

In autumn 2014 the Accessibility Research Group at the Department of Geosciences and Geography organized a PhD / MSc course entitled Analysing multimodal accessibility and mobility in urban environments. The course aimed at familiarizing the students with the current topics, theories, methods and data sources of spatial accessibility research in urban environments. This publication presents the outcomes of the course. The report begins with the Lectio precursoria given by Maria Salonen at the beginning of her doctoral defence that was part of the course program. The second part of this report is a collection of group reports written by the course participants. The group works presents an interesting collection of insights into multimodal accessibility questions in Greater Helsinki: the reader is invited to dig deeper into the topics of spatial accessibility to swimming pools, museums, Kela-services, grocery stores, urban parks, and water recreation environments.

Department of Geosciences and Geography C  
ISSN-L 1798-7938  
ISSN 1798-7938 (print)  
ISBN 978-952-10-9471-2 (paperback)  
ISBN 978-952-10-9472-9 (PDF)

Unigrafia 2015  
Helsinki



DEPARTMENT OF GEOSCIENCES AND GEOGRAPHY C9

# Analysing multimodal accessibility and mobility in urban environments

Final report of a PhD/MSc course at the Department of Geosciences and Geography, University of Helsinki, autumn 2014

MARIA SALONEN, HENRIKKI TENKANEN & TUULI TOIVONEN

# **Analysing multimodal accessibility and mobility in urban environments**

Final report of an intensive course at the Department of  
Geosciences and Geography, University of Helsinki, autumn  
2014

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## Foreword

Since 2009 the Department of Geosciences and Geography at the University of Helsinki has had a research group dedicated to studying spatial accessibility questions in the Helsinki region (<http://www.helsinki.fi/science/accessibility/>). During the past years, the MetropAccess-project has been funded by the Helsinki Metropolitan Region Urban Research Program (Katumetro). Alongside with active research and methodological development, the group has communicated its results and ongoing work through several seminars and courses.

During autumn 2014 the MetropAccess-project organized an intensive course entitled *Analysing multimodal accessibility and mobility in urban environments* for PhD and master students. The course aimed at familiarizing the students with the current topics, theories and methods of spatial accessibility research in urban environments. The course consisted of lectures held by the MetropAccess researchers and visiting speakers from other research institutes, a private company and city planning. One day was dedicated to hands-on exercises that introduced the open data sources and analysis tools developed by MetropAccess. The course also included a minisymposium open for everyone, where Rein Ahas (University of Tartu) and Anders Larsson and Erik Elldér (University of Gothenburg) presented their mobility-related research. One specific goal of the course was to introduce the students to the academic dissertation tradition and thus, the course ended at the PhD defence of Maria Salonen.

This report consists of two parts. The first one includes the *Lectio precursoria* given by Maria Salonen at the beginning of her defence. The speech introduces her thesis topic but at the same time it explains why the themes tackled during the course and in this report are important and topical. The second part of this report is a collection of course reports written by the course participants. Each group of participants selected an accessibility- or mobility related topic and studied it using the tools and data introduced during the course. The outcome of the group works presents an interesting collection of insights into multimodal accessibility questions in Greater Helsinki: the reader is invited to dig deeper into the topics of spatial accessibility to swimming pools, museums, Kela-services, grocery stores, urban parks, and water recreation environments.

In Helsinki, January 2015

Maria Salonen, Henrikki Tenkanen, Tuuli Toivonen



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# Lectio precursoria

**Maria Salonen**

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Menisinkö töihin pyörällä, autolla vai bussilla? Mikä on nopein tai mukavin reitti kauppaan ja sen jälkeen lähipuistoon? Tällaisia arkiliikkumisen kysymyksiä monet meistä pohtivat päivittäin. Tarve päästä paikasta toiseen on arkinen perustarve, ja liikkumisesta ja liikkuvuudesta onkin tullut keskeinen yhteiskuntiemme toimintaa ja rakennetta määrittelevä tekijä. Alueiden, palveluiden ja eri päivittäisten toimintojen saavutettavuus vaikuttaa asiointi- ja liikkumispäätöksiimme, arkemme sujuvuuteen ja vapauksiimme säädellä ajankäyttöä. Saavutettavuus saattaa ohjata asutokauppojamme tai ratkaista, harrastammeko judoa vai ratsastusta.

Aluetasolla saavutettavuuskysymykset liittyvät alueiden väliseen vuorovaikutukseen, alueiden taloudellisiin menestymismahdollisuuksiin, ja erilaisten ihmisten välisten kohtaamisten myötä ajatusten ja ideoiden virtaan, alueiden innovatiivisuuteen ja elinvoimaisuuteen. Kaupungit, joissa toiminnot ovat hyvin saavutettavissa, menestyvät tyypillisesti hyvin myös kilpailukykyvertailuissa.

Muutamat käynnissä olevat kehityskulut kaupungeissa eri puolilla maailmaa kuitenkin haastavat toiveet hyvästä saavutettavuudesta. Nopean väestön lisääntymisen myötä hajautuva yhdyskuntarakenne, tarve karsia julkista palveluverkostoa ja yhä enenevässä määrin monikeskuksinen kaupunkirakenne muuttavat ihmisten arkiliikkumista. Parhaimmillaan kaupunkirakenteet muutokset voivat parantaa yhteyksiä toimijoiden ja toimintojen välillä, mutta monin paikoin asutuksen ja päivittäisten toimintojen hajautuminen on johtanut pidentyneisiin arkimatkoihin ja asukkaiden riippuvaisuuteen autosta.

Saavutettavuus- ja liikkumiskysymykset kytkeytyvät läheisesti myös ympäristökysymyksiin: kaupunkiympäristössä päivittäiset liikkumisvalintamme ja eri kulkutapojen osuus liikkumisessamme vaikuttavat merkittävästi liikenteestä syntyviin ilmansaasteisiin ja meluun. Nykyisellään urbaani matkustajaliikenne tuottaa noin neljänneksen liikenteen hiilidioksidipäästöistä. Teknologisten ratkaisujen ohella ihmisten liikkumiskäyttäytymisen ohjaaminen kestävämpään suuntaan, esimerkiksi tukemalla vähäpäästöisempien kulkutapojen käyttöä on keskeinen tavoite päästövähennyksiä mietittäessä. Viime viikolla julkaistut tuoreet tilastot kertovat, että Eurooppa on saavuttamassa vuoden 2020 päästötavoitteensa, mutta liikennesektorin osalta tekemistä riittää vielä. Myös matkustajaliikenteen osalta tämä tarkoittaa sitä, että tasapainoilu saavutettavuuden parantamisen ja toisaalta kestävämpien liikkumistapojen ja -tottumusten tukemisen välillä jatkuu.

Saavutettavuus ohjaa myös ihmisen aiheuttamaa maankäytön painetta eri mittakaavatasoilla: mitä paremmin saavutettavissa alue on, sitä suurempi paine rakentamisen tai resurssien hyödyntämisen suhteen siihen pääsääntöisesti kohdistuu. Tropiikissa esimerkiksi metsänhakkuiden ja elinympäristöihin ja lajeihin kohdistuvan paineen on osoitettu olevan vahvasti kytköksissä saavutettavuuden rakenteisiin. Näin ollen saavutettavuuskysymykset ovat kiinteä osa myös globaalia maankäytön muutosta, joka on ilmastonmuutoksen ohella aikamme suurimpia haasteita.



Nämä mainitsemani yhteydet saavutettavuuden ja ajankohtaisten yhteiskunnallisten kehityskulkujen välillä paljastavat, että saavutettavuuskysymykset eri mittakaavatasoilla ovat hyvin keskeisiä suunnittelun kannalta. Erilaiset suunnitteluprosessit kaupunkisuunnittelusta maankäytönsuunnitteluun ja suojelusuunnitteluun kaipaavatkin enenevässä määrin tuekseen kvantitatiivista saavutettavuustietoa, joka on tuotettu asianmukaisilla ja testatuilla menetelmillä. Tiedeyhteisö on kehittänyt saavutettavuuden analysointiin menetelmiä jo hyvän aikaa. Jo sijaintiteorioiden pioneeri von Thünen hahmotteli 1800-luvulla teoreettisia malleja siitä, kuinka saavutettavuus vaikuttaa maankäyttöön. Toisin kuin tuolloin, nykyisin meillä on käsissämme valtavat määrät dataa jota voidaan hyödyntää saavutettavuustiedon tuottamiseen. Samanaikaisesti käytössä oleva laskennallinen kapasiteetti sallii näiden aineistojen tehokkaan käsittelyn ja alueellisesti kattavien, yksityiskohtaisten analyysien tekemisen. Laskennallisten menetelmien kehitys saavutettavuustutkimuksen tarpeisiin onkin ottanut huomioon harppauksia viime vuosikymmenen aikana. Erityisesti viimeaikainen kehitys kohti avointa aineistopolitiikkaa ja avoimia työkaluja on tuonut saavutettavuuden analyysimahdollisuudet aivan uudella tavalla tutkijoiden ja suunnittelijoiden käyttöön.

Näihin tässä puheessa esiin nostamiin teemoihin liittyy myös tänään tarkastettavalla väitöskirjani. Työlläni on kahdenlaisia tavoitteita: Yhtäältä tavoitteenani on ollut löytää uudenlaisia aineistolähteitä alueellisen saavutettavuusanalyysin tarpeisiin ja kehittää kvantitatiivisia saavutettavuuden mittaamisen menetelmiä, erityisesti etäisyyksien ja matka-aikojen osalta. Toisaalta tavoitteenani on erityyppisten visualisointien avulla kuvata ja ymmärtää saavutettavuuden alueellisia rakenteita tutkimusalueillani ja sen myötä keskustella saavutettavuuden merkityksestä näiden alueiden maankäytölle ja asukkaiden arkiliikkukselle.

Tarkastelen saavutettavuuskysymyksiä kahden hyvin erilaisen tutkimusalueen kautta. Kaksi työni artikkelia liittyy Loreton maakuntaan Perun Amazonian alueella ja kolme artikkelista käsittelee Suomen pääkaupunkiseutua. Nämä tutkimusalueet ovat monella tapaa toistensa vastakohtia: Loreto on pinta-alaltaan lähes Saksan kokoinen alue Globaalissa Etelässä, ja Suomen pääkaupunkiseutu Pohjois-Euroopassa kattaa sen pinta-alasta alle prosentin. Väestömäärältään alueet ovat kuitenkin suunnilleen saman suuruisia: molemmilla alueilla on reilu miljoona asukasta. Siinä missä Loretossa ihmisten ja tavaroiden liikkuminen tapahtuu suurelta osin alueen laajaa ja dynaamista jokiverkkoa pitkin, Suomen pääkaupunkiseudulla tieverkosto on liikkumisen perusta. Nämä kaksi aluetta tarjoavat myös tutkimusaineistojen saatavuuden osalta erilaiset ympäristöt: Amazonin alueella liikennejärjestelmään ja ympäristöön liittyvät aineistot ovat monilta osin hajanaisia tai vaikeasti saatavilla. Suomessa tilanne aineistojen laadun ja saatavuuden suhteen taas on kansainvälisesti verraten varsin hyvä: erityisesti Helsingin seutu on profiloitunut laadukkaiden ja ajantasaisten aineistojen avoimuuden puolestapuhujana, ja koko maan tasolla Opetus- ja kulttuuriministeriö on linjannut tavoitteekseen, että vuoteen 2017 mennessä Suomi nousee johtavaksi maaksi tutkimusaineistojen avoimuudessa.

Saavutettavuuskysymykset – ja tarve luotettavalle saavutettavuustiedolle – ovat varsin ajankohtaisia sekä Perun Amazoniassa että Suomen pääkaupunkiseudulla. Loretossa jokiverkosto ja siihen perustuva liikenne muodostaa alueen talouden selkärangan. Monien jokivarsien asukkaiden

elinkeinot ovat riippuvaisia laivaliikenteestä kylien ja alueen keskusten välillä, sillä yksi tärkeimmistä tulonhankkimiskeinoista on keräily- ja viljelytuotteiden myynti isompien kaupunkien markkinoilla. Lisäksi monet koulutusmahdollisuudet, terveydenhuollon palvelut ja laajemmat työmarkkinat ovat saatavilla vain suuremmissa keskuksissa. Jokiliikenne tarjoaa verrattain ekologisen ja valmiiksi olemassa olevan liikenneinfrastruktuurin - verrattuna vaikkapa Loreton naapurialueille rakennettuun tieverkostoon ja siitä seuranneeseen laajamittaiseen metsäkatoon. Arkiliikkumisen verkostona joet ovat kuitenkin haastava ympäristö alueen asukkaille: Jokien dynaamisuudesta ja liikennesektorin osin järjestäytymättömästä luonteesta johtuen epäsäännöllisyys, välillä jopa useiden päivien mittaiset yllättävät viivästykset ja yleinen ennustamattomuus ovat kiinteä osa asukkaiden arkiliikkumista. Alueella onkin tällä hetkellä käynnissä laajamittaisia infrastruktuuriprojekteja, joiden tarkoituksena on parantaa seudullisia liikenneyhteyksiä ja saavutettavuutta ja sen myötä tukea alueen taloudellista kehitystä. Näiden projektien ympäristövaikutukset ovat kuitenkin suuri huolenaihe erityisesti alueen monimuotoisen luonnon näkökulmasta. Samoin saavutettavuuden ja biodiversiteetin kytkökset liittyvät erilaisiin maankäytön suunnittelun pulmiin, erityisesti alueen tärkeiden luonnonvarojen – metsän ja öljyn – käyttöoikeuksia jaettaessa.

Suomen pääkaupunkiseudulla asukkaiden arkiliikkuminen kanavoituu useita rinnakkaisia liikenneverkostoja pitkin. Seudun asukasluku kasvaa nopeasti, ja täälläkin kaupunkirakenteen muutoskeskustelu on varsin ajankohtainen. Jokunen vuosi sitten Helsingin seutu nostettiin varoittavaksi esimerkiksi eurooppalaisesta kaupungista, jossa yhdyskuntarakenne hajautuu voimakkaasti. Valtakunnalliset trendit palveluverkostojen karsimisessa näkyvät myös pääkaupunkiseudulla. Toisaalta viime vuoden uutiset siitä, että joukkoliikenteen osuus on kääntynyt seudun sisäisessä liikenteessä nousuun ensimmäistä kertaa 50 vuoteen, kertoo kestävämpien kulkutapojen kilpailukyvyn kasvusta alueella. Juuri tällä hetkellä pääkaupunkiseutu on keskellä useita rinnakkaisia suunnitteluprosesseja, joita saavutettavuuden käsite yhdistää. Samalla kuin Helsingin kaupunki luo uutta, pian julkaistavaa yleiskaavaa ja kaupunkiaktiivit osallistuvat suunnitteluun varjokaavan myötä, Helsinki ja muut pääkaupunkiseudun kunnat ovat osa laajempaa seudullista suunnittelua, jossa liikennejärjestelmää, maankäyttöä ja asumista mietitään seudullisina kokonaisuuksina. Sekä kaupunki- että seututason suunnittelussa saavutettavuus on nostettu yhdeksi keskeisimmistä avainsanoista: vuoteen 2050 tähtäävissä visioissa sekä Helsingissä että koko seudulla asukkaat saavuttavat päivittäiset toiminnot nykyistä paremmin ja nykyistä kestävämmillä kulkumuodoilla.

Näille kahdelle erilaiselle alueelle tutkimukseni siis ankkuroituu. Tässä kuvaamani erot tutkimusalueiden välillä tarkoittavat käytännössä sitä, että työni yhdistää monenlaisia menetelmiä ja aineistoja vastatakseen saavutettavuuden kysymyksiin näillä alueilla. Alueiden eroista johtuen osa tuloksistani on hyvin paikallisia – ja kiinnostavia juuri paikallisuutensa tähden. Monet tuloksistani ovat kuitenkin yleistettävissä eri konteksteihin, ja se, että työssäni tarkastelen nimenomaan kahta näin erilaista aluetta, antaa mahdollisuuden tehdä tuloksistani laajempia ja yleisempiä päätelmiä kuin mitä yhden yksittäisen alueen tarkastelu olisi sallinut.

Tärkeimmät johtopäätökset työstäni voidaan tiivistää joukkoon yleisiä menetelmällisiä päätelmiä ja joukkoon tutkimusalueiden erityispiirteisiin liittyviä tuloksia. Menetelmälliset havaintoni korostavat sitä, kuinka keskeistä on mitata saavutettavuutta tutkimusalueelle relevanttien kulkutapojen ja

liikenneverkostojen näkökulmasta: matka-aikoihin perustuva kulkutapakohtainen tarkastelu saattaa paljastaa varsin erilaisen saavutettavuustodellisuuden kuin mitä perinteisemmät, pelkkiin etäisyyksiin perustuvat saavutettavuuden mittarit antavat ymmärtää. Vaikka kulkutapakohtaiset ja yksityiskohtaiset analyysimenetelmät ovat usein suositeltavia, ne vaativat taustalleen laadukkaita lähtöaineistot. Jos tällaisia aineistoja ei ole saatavilla, on keskeistä ymmärtää, kuinka hyvin yksinkertaisemmat etäisyysmitat toimivat saavutettavuuden mittareina. Työni osoittaa, että oikein yhdisteltynä ja sopivassa mittakaavassa ja kontekstissa käytettyinä linnuntie-etäisyydetkin voivat olla toimivia mittareita saavutettavuudelle ja ihmisen aiheuttamalle maankäytön paineelle. Suorat etäisyysmitat korreloivat kuitenkin erityisen huonosti joukkoliikenteen matka-aikojen ja toisaalta jokiverkostoon perustuvien todellisen matkareittien kuvaajina. Tapaustutkimukseni osoittavat myös, kuinka laskennallisten saavutettavuusmallien yhdistäminen asukkaiden todellisesta liikkumisesta kertovaan aineistoon tuottaa kiinnostavaa tietoa saavutettavuuden rakenteiden ja todellisten liikkumISRakenteiden välisistä eroista.

Väitöskirjani kansikuva on metrokarttaa muistuttava opas työni keskeisiin teemoihin. Sen tarkoituksena on asemien nimien avulla kiinnittää lukijan huomio keskeisiin asiasanoihin, ja toisaalta linjojen avulla linkittää samaan teemaan liittyvät asiasanat toisiinsa. Toisaalta tämä metrokartta muistuttaa myös sitä, kuinka keskeinen ja tehokas viestinnän väline kartta on – näin myös saavutettavuusanalyysien tuloksia viestittäessä. Monet tutkimukseni keskeisistä viesteistä tutkimusalueideni saavutettavuusrealiteetteihin liittyen onkin esitetty karttamuodossa: Amazonian alueella aikaetäisyysvyöhykkeet keskuskaupungin ympärillä auttavat hahmottamaan erityyppisten markkinatuotteiden mahdollisia viljelyalueita ja toisaalta ne kertovat maankäytön paineen alueellisesta jakautumisesta, mikä puolestaan linkittyy esimerkiksi metsäkatoon ja sen alueelliseen laajuuteen. Pääkaupunkiseudulla tilastoruutupohjaiset visualisoinnit eri kulkutapojen matka-ajoista auttavat hahmottamaan autoilu- ja joukkoliikennesaavutettavuuden valtavia eroja eri puolilla seutua, ja ruutupohjaiset visualisoinnit kirjastoasioinnista aiheutuvasta hiilipäästöistä kertovat erilaisten palveluiden sijoittelustrategioiden vaikutuksista asiointiliikkumisen potentiaalsiin päästömääriin.

Niin, menisinkö töihin pyörällä, autolla vai bussilla? Vai olisiko KutsuPlus-palvelu nopein vaihtoehto päästä kaupungin yhdeltä laidalta toiselle? Nämä arkiliikkumisen kysymykset vietyinä yleisemmälle tasolle olivat työni peruslähtökohtia, ja toivon, että nyt seuraava keskustelu johdattaa teidät syvemmälle näihin teemoihin.

# Analysing spatial accessibility patterns and travel times for swimming pools in Greater Helsinki – an active user's perspective

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## 1 Introduction

Spatial accessibility can be defined as an attribute of locations, indicating how easily certain places can be reached. Accessibility is strongly linked to the concept of mobility and thereby studying transport systems and travel times is relevant in accessibility research (Geurs & van Wee, 2004; Salonen, 2014). In other words, accessibility can be defined as the extent to which land-use and transport systems enable people to reach activities or destinations by means of a transport modes (Geurs & van Wee, 2004; Salonen, 2014) and hence spatial accessibility has been sometimes used also as a surrogate for economic activity (Uchida & Nelson, 2009).

As having inseparable linkage between temporal and spatial components, accessibility has been studied in the context of space-time geography (Hägerstrand, 1970; Meentemeyer, 1989; Couclelis, 1999), which makes a division between absolute and relative space. The concept of relative space defines space through processes, functions, and patterns and additionally may involve an individual component (Meentemeyer, 1989). Thus, accessibility can be perceived from an individual's or groups of individuals' point of view, focusing on different spatial and temporal constraints for human activities (Kwan, 1998; 1999).

Besides the distinction between place-based and individual-based accessibility (Geurs & van Wee, 2004), accessibility can be also categorized in terms of different measures. The simplest and likely the most used measure thus far has been Euclidean distance (absolute distances) which can be also said to measure absolute space (Danielsson, 1980; Meentemeyer, 1989; Salonen & Toivonen, 2013). Accessibility measures have been classified from simple connectivity measures to more comprehensive measures where accessibility is determined by both the urban environment and the person-specific space-time autonomy of individuals (Kwan, 1998).

Having an essential location-based character, accessibility is increasingly studied in the context of geoinformatics and geographical information systems (GIS). Specific notions of space and also time underlie GIS applications (Couclelis, 1999). Developments in GIS have greatly improved and facilitated the computation of the more advanced spatial accessibility measures, such as network distances, different types of cost distances, and travel times (Salonen, 2014). Network analysis tools are often based on Dijkstra's algorithm (Dijkstra, 1959). Nowadays, many commercial and open source GIS software provide tools for accessibility calculations.

Resource availability and accessibility have been identified as the most critical antecedents to human behaviour (Estabrooks et al., 2003). Therefore, accessibility is a vital measure when it comes to cost-efficient planning of public services. With accessibility measures we are able to review service areas

for certain services or take into account certain groups of individuals, for instance. Some researchers have emphasized spatial accessibility to public services regarding socio-economic position and area deprivation (Estabrooks et al., 2003; MacIntyre et al., 2008) while others have concentrated on gender differences (Kwan, 1999). The relationship between area deprivation and access to resources has been observed to vary greatly by resource and national context (MacIntyre et al., 2008).

Additionally, socio-regional context has been noticed to have a significant effect on health and well-being (Karvonen & Rimpelä, 1996; Pickett & Pearl, 2001; Bernard, 2007). Therefore, accessibility has an essential impact on the overall quality of life and health. Physical activity and sports are strongly linked to health (Caspersen et al., 1985; Warburton et al., 2006; Kulmala et al., 2011). Poor accessibility has been shown to have a negative impact on health behaviour and a linkage to obesity (Timperio et al., 2004; Billaudeau et al., 2011). Consequently, accessibility to public sport facilities can be also seen as a socio-economic and political issue.

Thus far, a limited amount of research has focused on accessibility to sport facilities and leisure activities (Smoyer-Tomic et al., 2004; Billaudeau et al., 2011; Karusisi et al., 2013) not to mention individual-based accessibility to sport facilities (Wolch et al., 2011). In Finland, there has recently been a project examining the quality and accessibility of sports services (Kotavaara et al., 2014). The target has been to evaluate how municipalities' sports facilities are placed in relation to the location of the population and to observe if the amount of municipal basic sports facilities is sufficient in relation to the amount of population.

Here, we examine the spatial accessibility to swimming pools in Greater Helsinki area, in the capital region in Finland. According to swimming pool barometer from 2012 (Suomen uimaopetus- ja hengenpelastusliitto, 2012) Finnish people are enthusiastic swimmers and especially in Greater Helsinki area some swimming pools have been very popular (Helsingin uutiset, 2013). Swimming pools are part of public services provided by the municipalities and hence part of community planning (Jokela, 2009). Swimming pools differ from other forms of indoor sports in a way that they are specialized public services and in a municipal scale there are not so many pools. It is a big investment for municipalities to build new swimming pools or renovate old ones (Häyrynen, 2013; Metro, 2014). Therefore, it is relevant to detect the accessibility of swimming pools. Increasingly, sustainable development has been incorporated in community planning strengthening the inclusion of accessibility in planning processes (Jokela, 2009; Häyrynen 2013, Lahtinen et al., 2013). In order to make sustainable and cost-efficient solutions in planning it is relevant to be aware of accessibility patterns to public services like swimming pools.

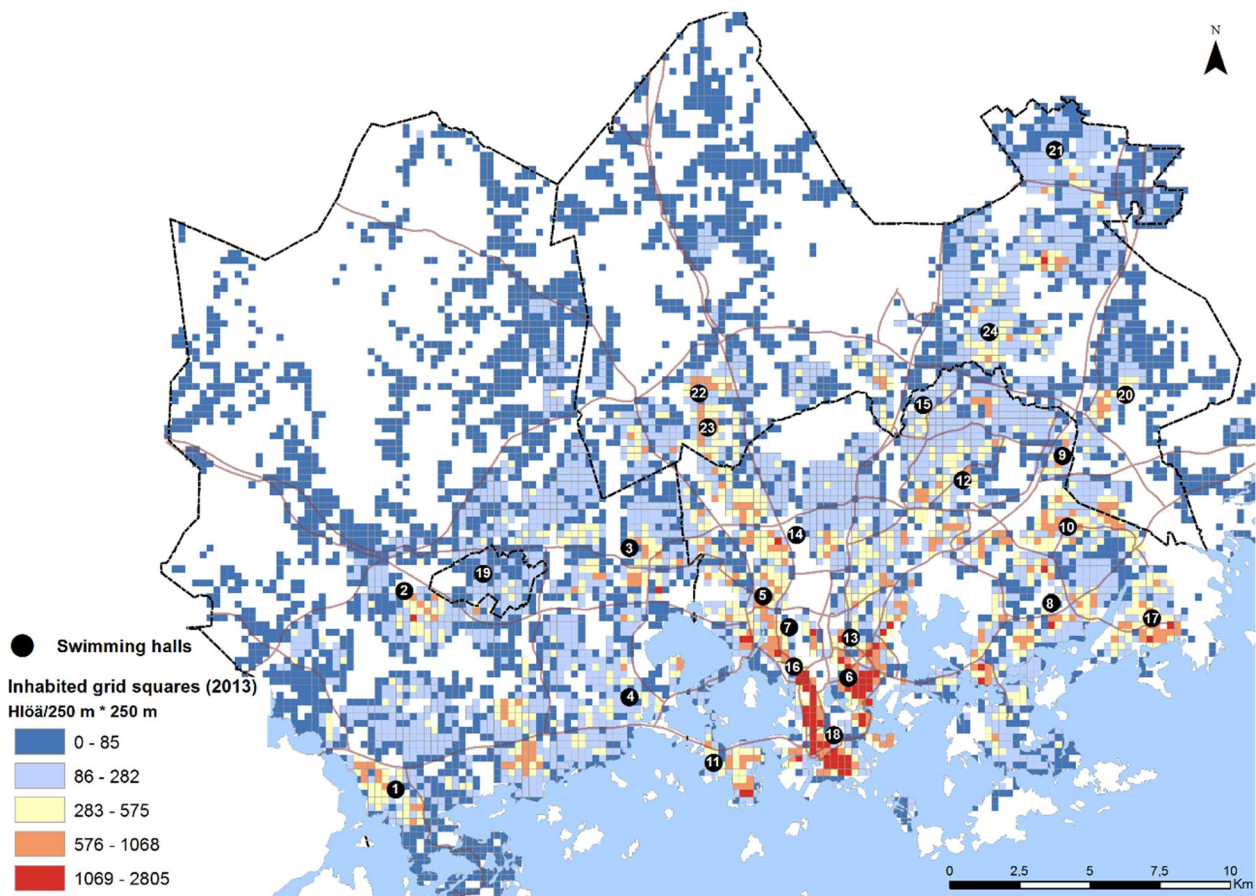
Our objectives include i) an overall assessment of the swimming pool service area in Greater Helsinki area, and ii) identification of gaps in the service area network. We also examine iii) the travel times to swimming pools by private car and public transport (PT). Finally, iv) we take a special focus on the individual-based accessibility and recognize accessibility patterns for active swimmers, in terms of evaluating how accessible the swimming facilities are. We combine person-based accessibility with place-based approach by measuring travel times from active swimmers' homes to swimming pools.

## 2 Data and methods

We derived kml-format data about public swimming facilities in Greater Helsinki area from Palvelukartta website (Palvelukartta, 2014) and processed it in ArcGIS 10.2 to be feasible in the analyses. We excluded public beaches, outdoor pools, and small spas from our selection due to their seasonal characters and their potentiality to provide required services for active or competitive swimmers. Finally, there were 24 indoor swimming pools in Helsinki, Espoo, Vantaa, and Kauniainen to be included in the study (Figure 1). The swimming pools are described in more detail in Table 1.

Swimming pools are somewhat evenly distributed in Greater Helsinki area (Figure 1). There is one swimming pool in Kauniainen, five in Vantaa, four in Espoo, and remaining 14 in Helsinki (Table 1). However, swimming pools differ in their size and capability to provide services for different groups, e.g. Mäkelänrinne is known for its ability to provide services and high quality training facilities for active and competitive swimmers (Helsingin kaupunki, 2013)

Mäkelänrinne, Itäkeskus, and Espoonlahti are the largest swimming pools in terms of the pool total size (m<sup>2</sup>). When it comes to visitors per year, Mäkelänrinne, Itäkeskus and Vuosaari are the largest swimming pools in Greater Helsinki. The smallest swimming pools are Siltamäki and Korso due to their pool total size (m<sup>2</sup>). We categorized all 24 swimming pools according to their capability to provide parking space (Table 1). Almost all swimming pools provide parking space except Urheilutalo, Töölö, and Yrjönkatu where parking is dependent on street parking (Table 1; UKTY 2014.)



**Figure 1.** Swimming pools in Greater Helsinki area (ID codes for each swimming pool are listed in table 1).

**Table 1.** Selected swimming pools from Greater Helsinki area.

Swimming pool	ID	Parking lot type	Year of construction	Pool total size (m2)	Visitors/year
Espoonlahti	1	Parking lot	1983	1300	340000
Keski-Espoo	2	Parking lot	2003	516	250000
Leppävaara	3	Parking lot	1961	553	145692
Tapiola	4	Parking lot	1965	935	250000
Haaga	5	Parking lot	1972	242	56000
Invalidisäätiö	6	Parking lot	n/a	n/a	n/a
Itäkeskus	7	Parking lot	1993	1281	378761
Jakomäki	8	Parking lot	1972	249	53000
Kontula	9	Parking lot	1970	284	81572
Lauttasaari	10	Parking lot	1968	250	225000
Malmi	11	Parking lot	1983	490	329000
Mäkelänrinne	12	Parking lot	1999	2064	555953
Pirkkola	13	Parking lot	1968	575	180000
Siltamäki	14	Parking lot	1973	154	53695
Töölö	15	Street Parking	1967	407	140646
Urheilutalo	16	Street Parking	1961	391	133272
Vuosaari	17	Parking lot	1980	921	400000
Yrjönkatu	18	Street Parking	1927	365	130000
Kauniainen	19	Parking lot	1973	356	120000
Hakunila	20	Parking lot	1982	730	n/a
Korso	21	Parking lot	1970	200	n/a
Martinlaakso	22	Parking lot	1972	322	70000
Myyrmäki	23	Parking lot	1974	751	278000
Tikkurila	24	Parking lot	1968	800	254000

As part of the analyses we used inhabited YKR 250 m x 250 m grid cells ( $n = 13\,230$ ) from Greater Helsinki area provided by the Finnish Environmental Institute (2013). For identifying gaps in the swimming pool service area network, we compared present swimming pool locations with areas that lack swimming pool and where the amount of population is high (based on the YKR grid squares). The total population in Greater Helsinki in 2013 was 1 052 101.

Our person-based material covered data about active swimmers from Greater Helsinki area, provided by the Finnish Swimming Association (2014). For travel time calculations, we determined active swimmers' homes ( $n=1681$ ) as origin points. Respectively, swimming pools ( $n=24$ ) were used as destination points.

To investigate spatial accessibility and travel times for swimming pools we used the following tools: i) MetropAccess Digiroad tools (4. *Kokonaismatkaketjujen laskenta* and 5. *Palvelualueen laskenta*) for ArcGIS 10.2 to calculate travel times and service areas by private car, ii) MetropAccess Travel Time Matrix for calculating the service areas for PT and car, and validating the car service areas calculated with Digiroad tools (Figure 2, Jaakkola 2013, Jaakkola et al., 2014, Toivonen 2014), iii) MetropAccess Reitin 1.2 for calculating the travel times and total travel chains by PT. The tools used are all developed by the Accessibility research group at the University of Helsinki and they are all open source and available for download (Tenkanen et al., 2014; MetropAccess, 2014; MetropAccess & BusFaster, 2014).

Our travel time measures and accessibility analyses were based on door-to-door-approach; advanced car and advanced PT (Salonen & Toivonen, 2013; Salonen, 2014). The door-to-door-approach for



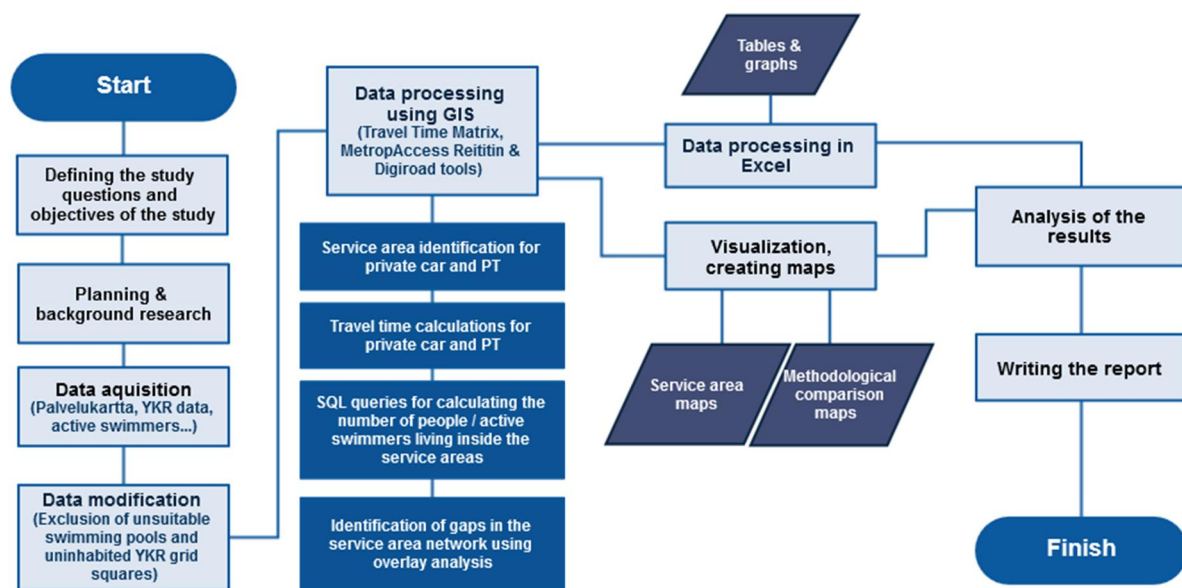
private car takes the whole travel chain into account, including time spent for walking from the origin point (home location) to the parking lot, driving to near the destination, searching for a parking space and walking from the parking lot to the destination (swimming pool).

For PT, the travel chain is rather similar, but the travel mode used is one or several PT modes (bus, metro, train or tram) depending on optimal route. It also includes the possible transfers from one mode to another and the scheduled waiting time between the transfers. The door-to-door method is described in more detail by Salonen & Toivonen (2013).

For defining the service areas for swimming pools, travel time thresholds for PT and private car analyses were determined as 10 and 20 minutes (Figure 3, 4; Table 1S, 2S). These have been shown to be feasible for visual comparisons between car and PT travel times in urban environments, based on previous studies (Salonen, 2014). The walking speed was set to default (70m/min) representing an average user (MetropAccess, 2014). When calculating the service areas for private car, the impedance values were set based on the midday travel time average (09:00 – 14:59) as the MetropAccess Travel Time Matrix is based on similar intersection delay calculations (12:00) (Jaakkola, 2013). Service areas for 10 minutes by private car were also calculated for rush hour times (07.00-08:59, 15:00-16:59) (Figure 2S). We used the default parking type since there was no option to define parking lot types for each swimming pool separately.

For the Travel Time Matrix analyses, we derived the individual squares (YKR grids) where the swimming pools were located. Then we queried and extracted those grid squares that had at maximum 10 and 20 minute travel time for PT from each swimming pool square. The same procedure was also done for private car and walking.

MetropAccess Reititin (MetropAccess & BusFaster, 2014) was used to calculate the total travel chains and times from each active swimmers' homes to all swimming pools (n=24). From the outputs we were able to calculate average travel times and examine travel chains for midday and congestion times separately.



**Figure 2.** Flow chart about the work process.

### 3 Results

#### *Service areas for swimming pools*

In general, the service areas for swimming pools by private car are comprehensive and the great majority of population in Greater Helsinki can reach at least one swimming pool in 20 minutes (Figure 3). Only Laajasalo and the some scarcely populated areas in the northern parts of Vantaa and Espoo have somewhat low accessibility to swimming pools by car. The size of the service areas decrease significantly as the travel time is cut in half to 10 minutes, still representing relatively good accessibility. The service area network is the most comprehensive in Helsinki, especially in the inner city area, compared to the whole study area (Figure 3).

Respectively, service areas for swimming pools which are accessible both in 10 and 20 minutes by public transport are significantly smaller than service areas by car (Figure 4). Overall, service areas by private car are much larger than by PT (Figure 5). For instance, when comparing the 10 minute service area for Korso swimming pool by private car, service area for car is larger than the respective 20 minute service area for PT (Figure 3, 4). Swimming pools are located somewhat close to railways especially in Espoo and Vantaa (Figure 4), enlarging the service areas and improving accessibility by PT. In Helsinki, metro improves the accessibility by PT especially to Itäkeskus and Vuosaari.

#### *Gaps in the service area network?*

The service network for swimming pools can be said to be comprehensive in Greater Helsinki area, especially when we look at accessibility by private car (Figure 3). Nonetheless, we identified several gap areas for swimming pools in Greater Helsinki (Figure 1, 3, 4). We identified several areas where population densities are high, but the accessibility for swimming pools is somewhat poor.

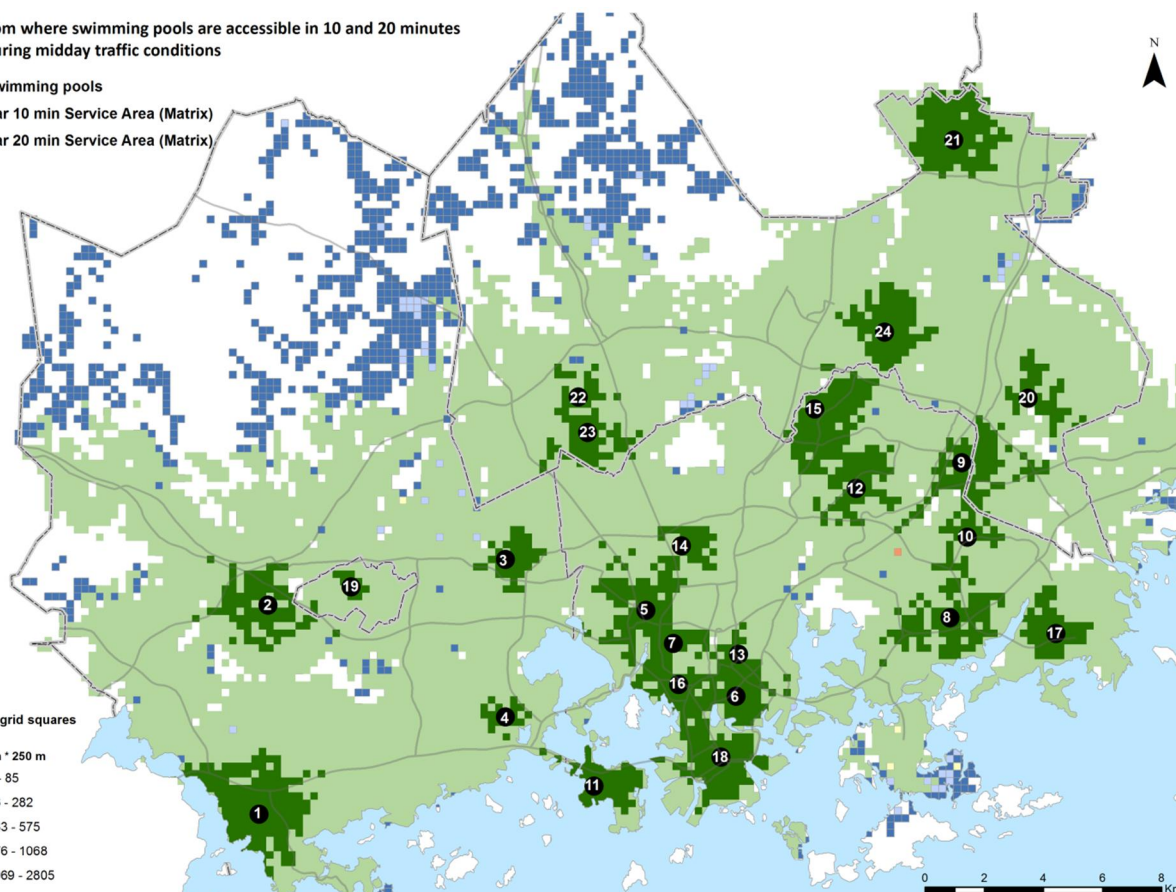
One of the gap areas is located in Herttoniemi (Helsinki), where population density is sufficiently high, but the area does not have an own swimming pool. Secondly, another area that lacks an own swimming pool is Olari / Matinkylä region in southern Espoo. Nowadays, there is a very small swimming pool in Olari but it was left out of this study due to its poor capability to provide services for active users (e.g. only one 15 m pool available) (Espoon kaupunki 2013). Espoo is renewing its service network for swimming pools and a new swimming pool will be opened in Matinkylä in near future (Espoon kaupunki 2013). There have also been plans to improve the current service areas by building a new swimming pool to Jätkäsaari (Helsingin kaupunki 2014). Thirdly, we recognize at least one densely populated area from Vantaa (Koivukylä region) where there is reasonably low accessibility to swimming pools.

Areas from where swimming pools are accessible in 10 and 20 minutes  
by car during midday traffic conditions

- Swimming pools
- Car 10 min Service Area (Matrix)
- Car 20 min Service Area (Matrix)

Inhabited grid squares  
(2013)  
H100/250 m \* 250 m

0 - 85
86 - 282
283 - 575
576 - 1068
1069 - 2805



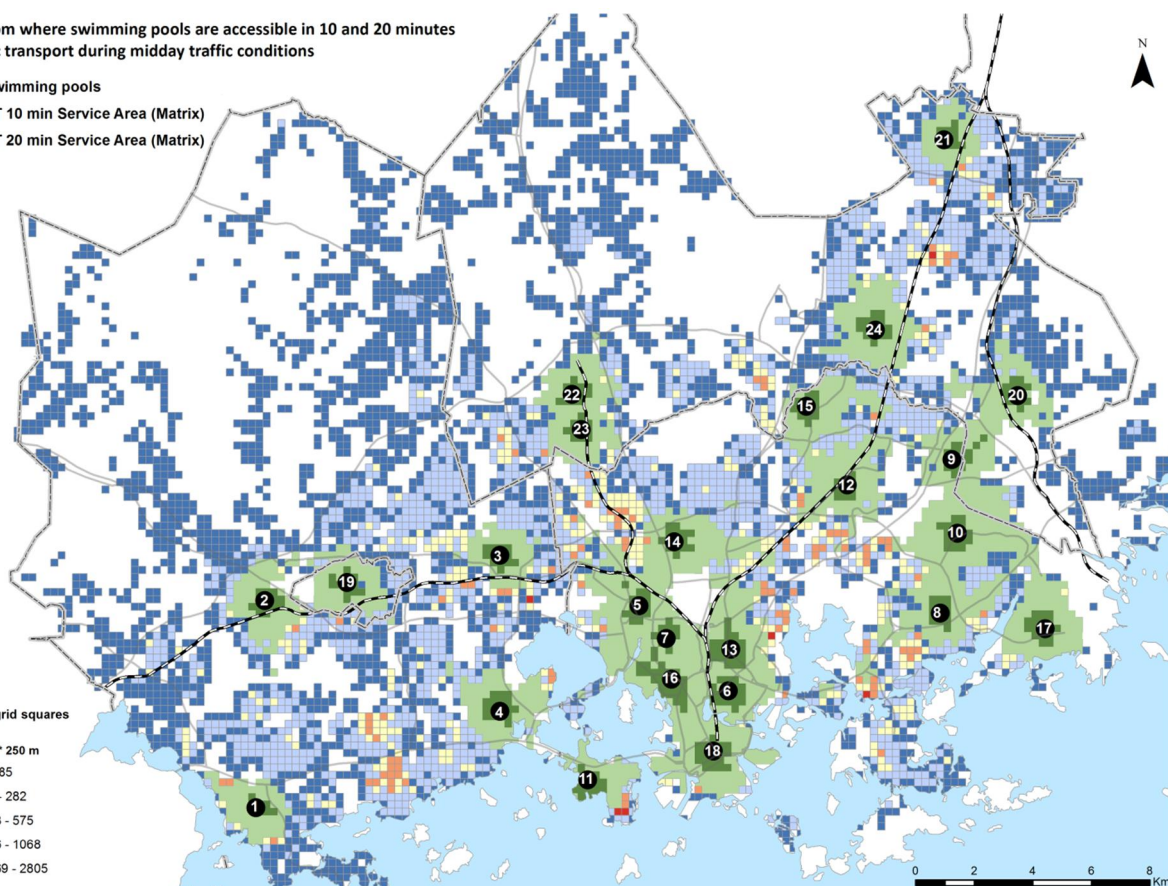
**Figure 3.** Areas from where swimming pools are accessible in 10 and 20 minutes by private car.

Areas from where swimming pools are accessible in 10 and 20 minutes  
by public transport during midday traffic conditions

- Swimming pools
- PT 10 min Service Area (Matrix)
- PT 20 min Service Area (Matrix)

Inhabited grid squares  
(2013)  
H100/250 m \* 250 m

0 - 85
86 - 282
283 - 575
576 - 1068
1069 - 2805



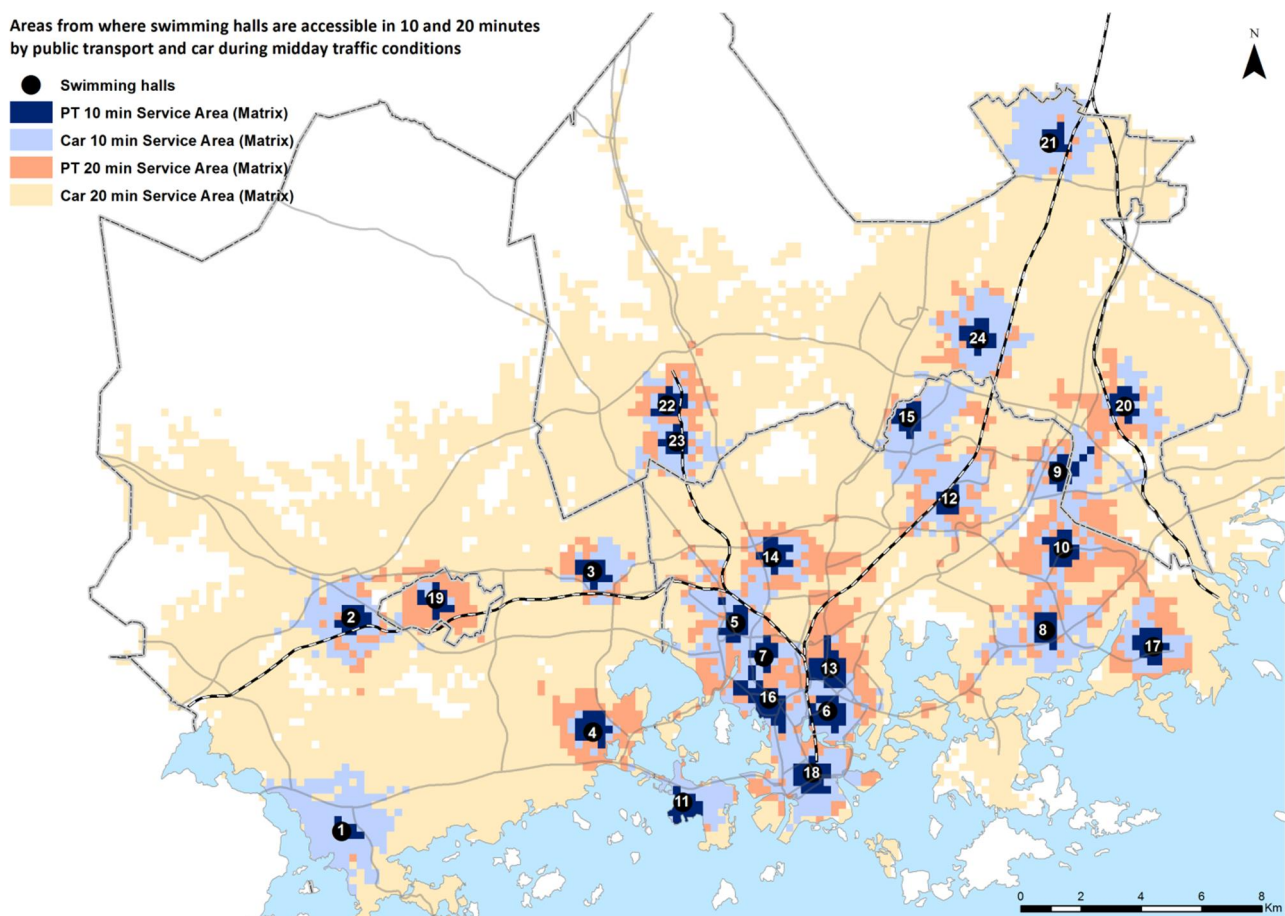
**Figure 4.** Areas from where swimming pools are accessible in 10 and 20 minutes by public transport.



### *Travel time comparison between private car and PT*

In addition to service areas, comparisons between private car and PT reveal major differences in accessibility in terms of travel times (Table 1S, 2S, 3S; Figure 5). Private car performs better nearly in all areas and all 24 swimming pools are well accessible by private car. However, there are major differences in the accessibility between swimming pools. According to our calculations Haaga swimming pool has the best accessibility regarding travel time with private car in 20 minutes, reaching 42.02 % of total population in Greater Helsinki area. Respectively, Invalidisäätiö swimming pool reaches 36.90 % of population by car in 20 minutes and Töölö reaches 38.26 %. The lowest accessibility in terms of how much population swimming pool reaches in 20 minutes by car is Kauniainen swimming pool (5.5 %) (Table 2S).

When it comes to PT travel times the best accessibility is found from the swimming pools located near the city centre of Helsinki. Yrjönkatu reaches most population in Greater Helsinki by PT, reaching 10.8 % of total population in 20 minutes. Respectively, Töölö is the top swimming pool in terms of PT accessibility in 10 minutes, reaching 1.4% of total population. The lowest accessibility by PT is found from Pirkkola and Korso (Table 1S, 2S).



**Figure 5.** Service area comparison between private car and public transport (PT).

### *Individual-based accessibility assessment for active swimmers*

The swimming pool service areas in relation to active swimmers follow the same pattern as for the whole population (Figures 3, 4, 7, 8). Almost all active swimmers live in the 20-minute service area (private car). Many active users are reasonably young based on the median year of birth in our data which was 1996 (Finnish Swimming Association, 2014). As a result of active users' age we wanted to specially look into more detail our results on the differences in accessibility by car and PT. Without having a driver's license, youngsters are more likely to use PT in their travels. However, many parents take their kids to their hobbies by car; according to Häyrynen (2013) 44.7 % of all children's travels for sport hobbies are done by private car.

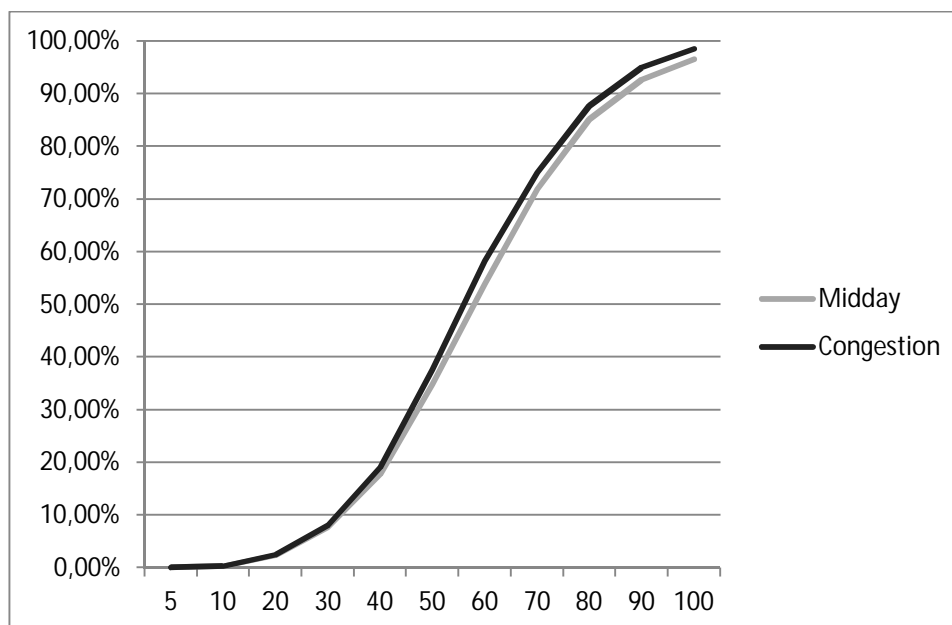
We compared travel times from active swimmers' homes to all swimming pools in Greater Helsinki. Comparisons were made based on travel mode (private car and PT) and temporality (midday / congestion time). The average travel time by private car from the active swimmers' homes to the closest swimming pool during midday traffic conditions is 13.4 minutes and 14.9 minutes during rush hour times. Averages to all swimming pools are for midday 29.1 minutes and 33.3 minutes for congestion. Respective numbers for PT were 58.4 minutes at midday and 56.3 minutes during congestion (Table 2).

However, there are differences between swimming pools whether they have better accessibility during midday or congestion (Table 2). For car, the travel times during congestion times are approximately four-five minutes longer to all swimming pools. Instead for PT the majority of swimming pools are more accessible during congestion, except some swimming pools located in suburban areas near arterial roads such as Itäväylä and Länsiväylä that are likely to have traffic jams during congestion (Jakomäki, Kontula, Vuosaari, Espoonlahti, and Lauttasaari). The shorter average travel time during congestion is likely due to increasing number of available PT connections.

Based on calculations with MetropAccessReitin, 53.86 % of active swimmers reach all swimming pools at noon in 60 minutes by PT. The curves (Figure 6) show similar kind of result for PT that has been observed in previous studies which have been used advanced PT model for calculating total travel times (Salonen & Toivonen, 2013). We also compared average travel times by PT for all pools (Table 2) and for the biggest (visitors/year) swimming pools (Mäkelänrinne, Espoonlahti and Myyrmäki) in each municipality, except Kauniainen (Figure 3S, 4S). Average travel time for all pools at midday varies from 46 minutes (Yrjönkatu) to 84 minutes (Korso) and for the selected pools between 56 minutes (Myyrmäki) to 62 minutes (Espoonlahti) (Figure 3S, 4S, Table 2).

**Table 2.** Average travel times from active swimmers homes to each swimming pool based on MetropAcces Reititin and MetropAccess Digiroad tool 4.

ID	Swimming pool	Total Travel time by PT (min)		Total Travel time by car (min)		Car travel time - PT	
		midday	congestion	midday	congestion	Midday difference	Congestion difference
1	Espoonlahti	62.6	63.3	33.3	38.3	-29.3	-25.1
2	Keski-Espoo	59.4	57.3	29.6	34.0	-29.8	-23.3
3	Leppävaara	60.3	56.7	25.6	29.3	-34.7	-27.4
4	Tapiola	55.0	52.2	28.7	32.6	-26.3	-19.6
5	Haaga	49.9	49.2	25.1	28.5	-24.8	-20.7
6	Invalidisäätiö	48.6	47.1	24.7	28.5	-24.0	-18.6
7	Itäkeskus	56.4	54.6	24.0	27.5	-32.4	-27.0
8	Jakomäki	52.1	56.3	28.8	32.7	-23.3	-23.6
9	Kontula	63.0	63.4	31.0	35.2	-32.0	-28.2
10	Lauttasaari	55.8	57.5	33.8	38.1	-22.0	-19.5
11	Malmi	63.0	60.7	27.5	31.6	-35.5	-29.1
12	Mäkelänrinne	58.5	52.8	27.5	31.4	-31.1	-21.4
13	Pirkkola	48.3	48.2	27.7	31.9	-20.7	-16.4
14	Siltamäki	53.8	51.2	25.4	28.6	-28.4	-22.7
15	Töölö	60.5	57.8	28.8	33.4	-31.7	-24.4
16	Urheilutalo	46.7	45.6	23.5	26.9	-23.2	-18.7
17	Vuosaari	61.2	65.7	36.4	41.6	-24.9	-24.1
18	Yrjönkatu	46.0	45.4	25.6	29.1	-20.5	-16.3
19	Kauniainen	63.0	55.0	33.3	38.1	-29.7	-16.9
20	Hakunila	77.8	66.7	34.0	38.6	-43.8	-28.1
21	Korso	83.6	74.3	39.5	45.7	-44.0	-28.6
22	Martinlaakso	57.0	54.9	27.0	31.3	-30.0	-23.5
23	Myyrmäki	56.0	54.0	28.2	32.1	-27.8	-21.9
24	Tikkurila	62.7	60.8	30.0	34.4	-32.6	-26.4
Average		58.4	56.3	29.1	33.3	-29.3	-23.0

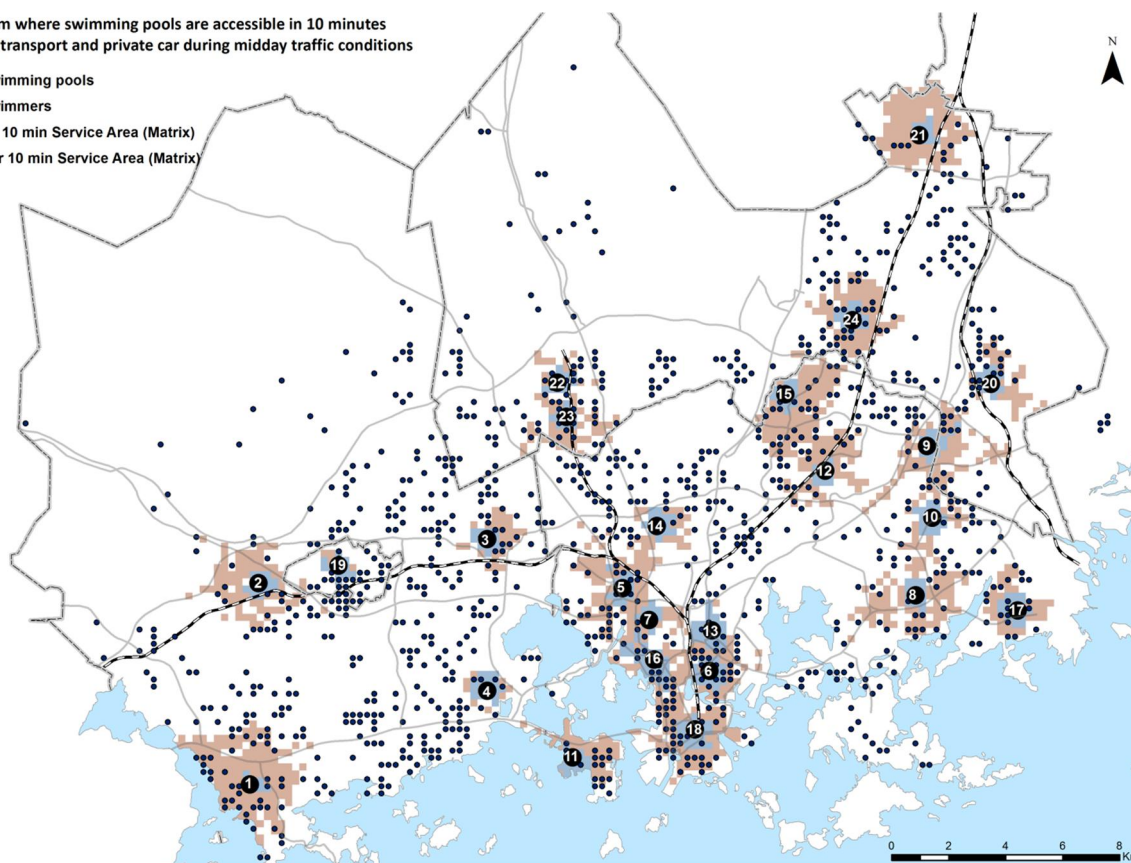


**Figure 6.** The travel times in minutes for all swimmers to all swimming pools.



Areas from where swimming pools are accessible in 10 minutes  
by public transport and private car during midday traffic conditions

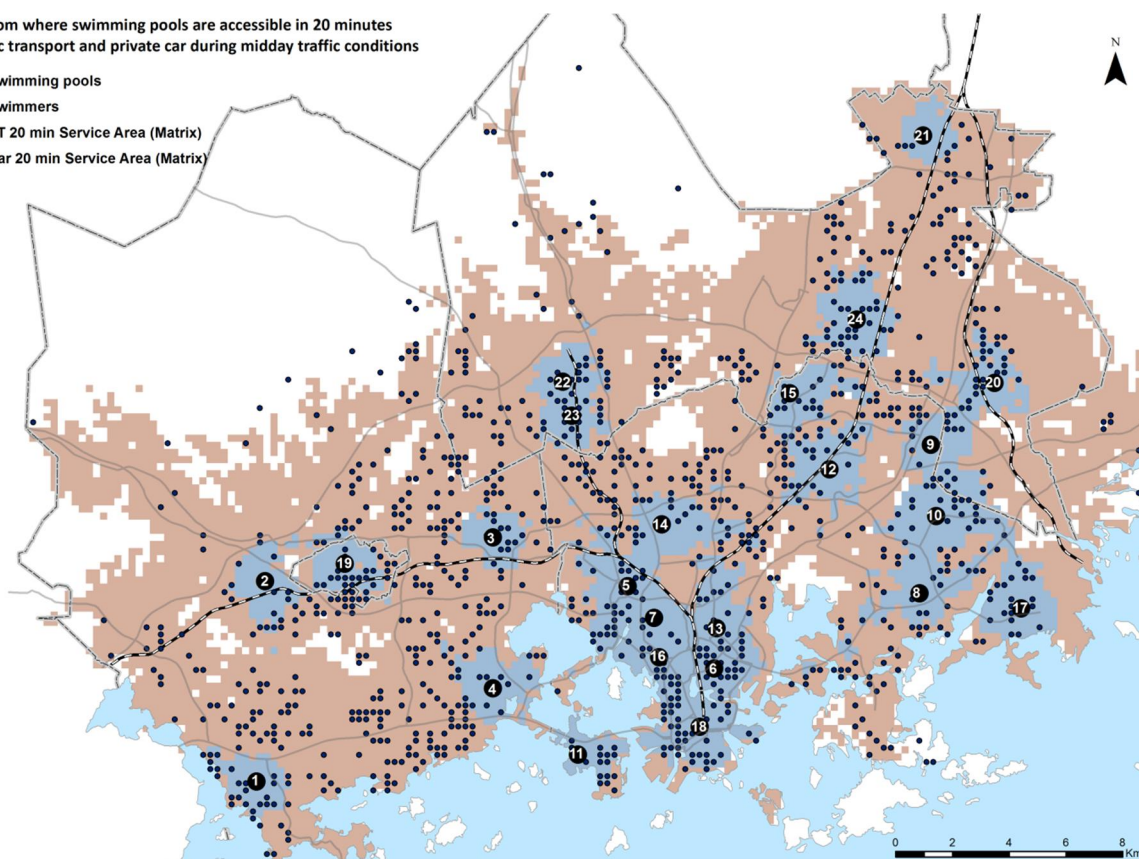
- Swimming pools
- Swimmers
- PT 10 min Service Area (Matrix)
- Car 10 min Service Area (Matrix)



**Figure 7.** The homes of the active swimmers and 10 minute service areas for car and PT.

Areas from where swimming pools are accessible in 20 minutes  
by public transport and private car during midday traffic conditions

- Swimming pools
- Swimmers
- PT 20 min Service Area (Matrix)
- Car 20 min Service Area (Matrix)

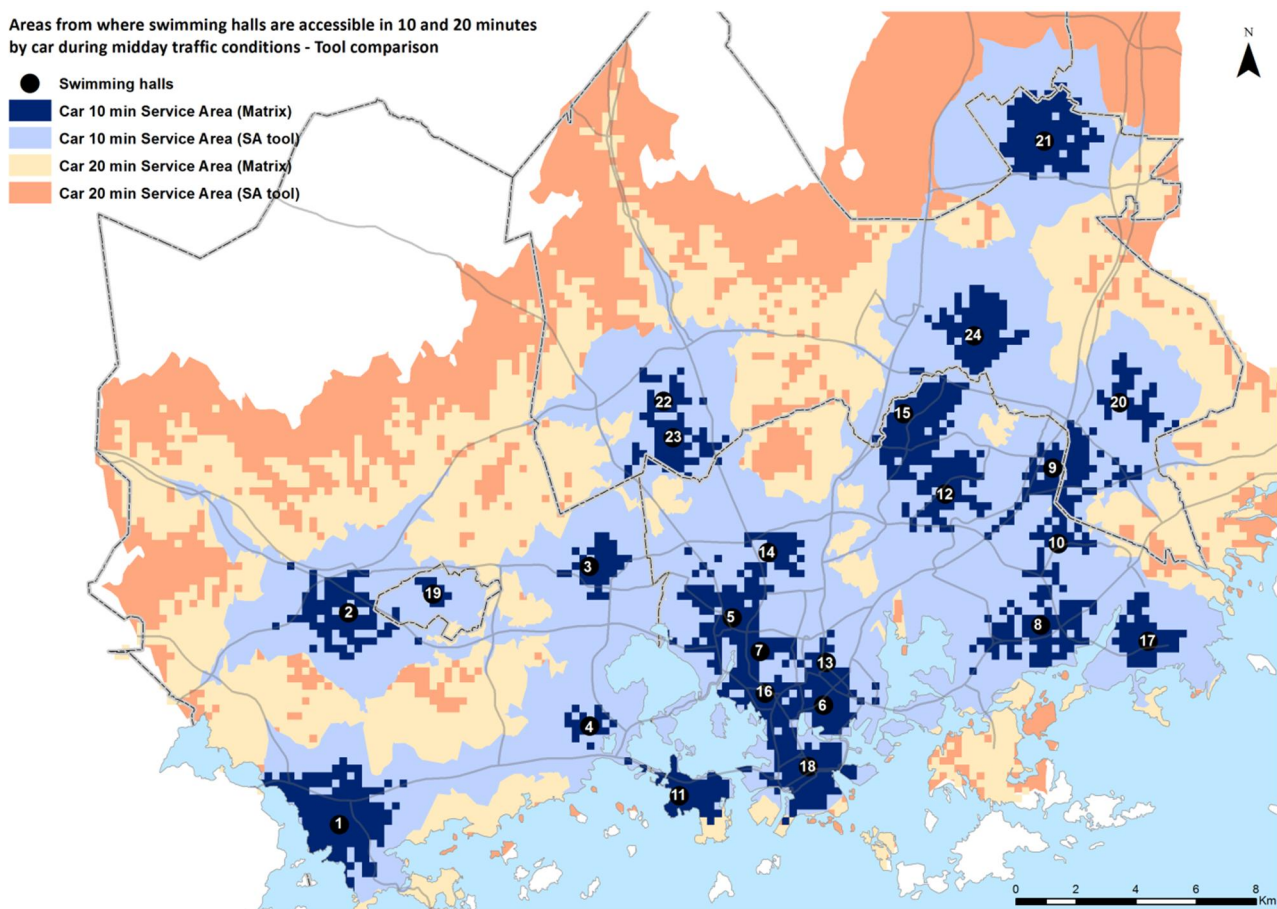


**Figure 8.** The homes of the active swimmers and 20 minute service areas for car and PT.



### Methodological comparison

To validate the results, we created 10 and 20 minute service areas for private car by using the Travel Time Matrix. We found a notable difference between the matrix-based and the Digiroad service area tool (SA-tool)-based service areas for cars (Figure 9). Both the 10 and 20 minute SA-tool-based service areas are substantially larger compared to matrix-based areas. The biggest differences are seen in Espoo where the SA-tool-based 10 minute service area is continuous near the motorway but the matrix-based service area only covers the nearest squares around the origin point square. Also in Viikki in Helsinki, SA-tool-based 10 minute areas form a large continuous zone while matrix-based service areas consists of more dispersed squares. As for 20 minute service areas, the SA-tool-based areas reach much further towards the outskirts of the area, especially near the major highways.



**Figure 9.** Comparison between the 10 and 20 minute service areas for car calculated with the MetropAccess Digiroad Service Area tool and Travel Time Matrix.

## 4 Discussion and conclusions

Based on previous studies, accessibility has been shown to be the most important component determining how actively services like sport facilities are utilized in urban areas (Häyrynen, 2013; Karusisi et al., 2013). Our results support previous research results about accessibility to public services (Saarsalmi, 2014; Lahtinen et al., 2013). Transport mode has a huge impact on the swimming

pool accessibility in Greater Helsinki. Comparisons between PT and private car show that service areas for swimming pools are very comprehensive by car while the respective service areas for PT are significantly smaller. Majority of population can access at least one swimming pool in 20 minutes by car.

One of the deficiencies in this study was that we did not take into account seasonal variation. There is seasonal variation in the usage of swimming pools in Greater Helsinki area. Many swimming pools are closed in the summer while many public beaches and outdoor pools are popular at that time of the year. We considered only indoor swimming pools, and therefore we are inevitably lacking a certain temporal component of accessibility from our study. Instead, we looked at temporal variation during daytime (e.g. congestion times). We found, in addition to the used transport mode, time of day has an impact on accessibility in terms of travel times. Additionally, we did not consider travel times for the closest swimming pool for each swimmer by PT.

We studied individual-based accessibility from active swimmers' point of view. When it comes to individual mobility in relative space, non-euclidean distances, transformed space and individual perceptions of travel times are emphasized (Meentemeyer, 1989). It would have been reasonable to supplement our results with a user survey targeted to active swimmers. In this study we did not get detailed information about swimmers subjective perceptions and specialized travel chains in their space-time cube (Hägerstrand, 1970). The door-to-door approach in calculating travel routes and times is also problematic methodologically. Measures which evaluate accessibility based on a single reference location such as the home are ignoring the fact that many trips that contribute to individual accessibility are made in the context of the sequential unfolding of a person's daily activity program (e.g. all travels to swimming pools are not originating from users home) (Figure 1S). These same challenges have been observed before in person- and group-based individual accessibility studies (Kwan, 1998; 1999).

One interesting question also remains – how can we define good accessibility to swimming pools? Karusisi et al. (2013) found that the probability to use swimming pool is greater if it is located not more than 1 km away from home. In the context of food stores, travel time less than 16 minutes has been interpreted as a good accessibility. Respectively, good accessibility to food stores in terms of physical distance is determined as 1 km (corresponding 15 minute walk) (Saarsalmi, 2014). When it comes to swimming pools, good service areas are likely to be larger than for food stores. As a specialized public service, swimming pools can have larger service areas. Not to forget that accessibility has a strong individual component, it has an effect on the subjective idea about good accessibility. Therefore, it may be hard to define what good accessibility in terms of time is.

Another interesting question is that is the nearest service always the most used. It is likely that there are also other criteria (e.g. swimming societies' habits and how equipped the facilities are) for choosing a swimming facility, especially in terms of active user groups. Many people also use other services in swimming pools, e.g. gym services (Häyrynen, 2013). Accessibility indices have been used in municipal planning in order to determine accessibility in non-spatial way (Häyrynen, 2013). These indices have operationalized accessibility in terms of different variables (e.g. other local sport

facilities, parking space, pedestrian and cycle paths, fees, etc.), but they are not able to include detailed information about spatial accessibility and travel times.

In terms of methodology, we found that the service areas for private car derived using SA-tool and the Travel time matrix differed notably. According to one developer of the tools, Henrikki Tenkanen (2014), the Travel time matrix is based on MetropAccess Digiroad tool 4, which calculates the total travel chain, while tool 5 (SA-tool) uses a slightly different logic to calculate the service area. For instance, the walking and parking times are taken into account in more detail in the Travel time matrix, thus it can be assumed to be more reliable. However, major improvements in GIS methods have a significant effect in accessibility research. To conclude, GIS applications will have a great potential facilitating municipal planning in terms of different public services.

## Acknowledgements

We thank our enthusiastic teachers in the Accessibility course for providing the data from Finnish Swimming Association.

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## Supplementary material

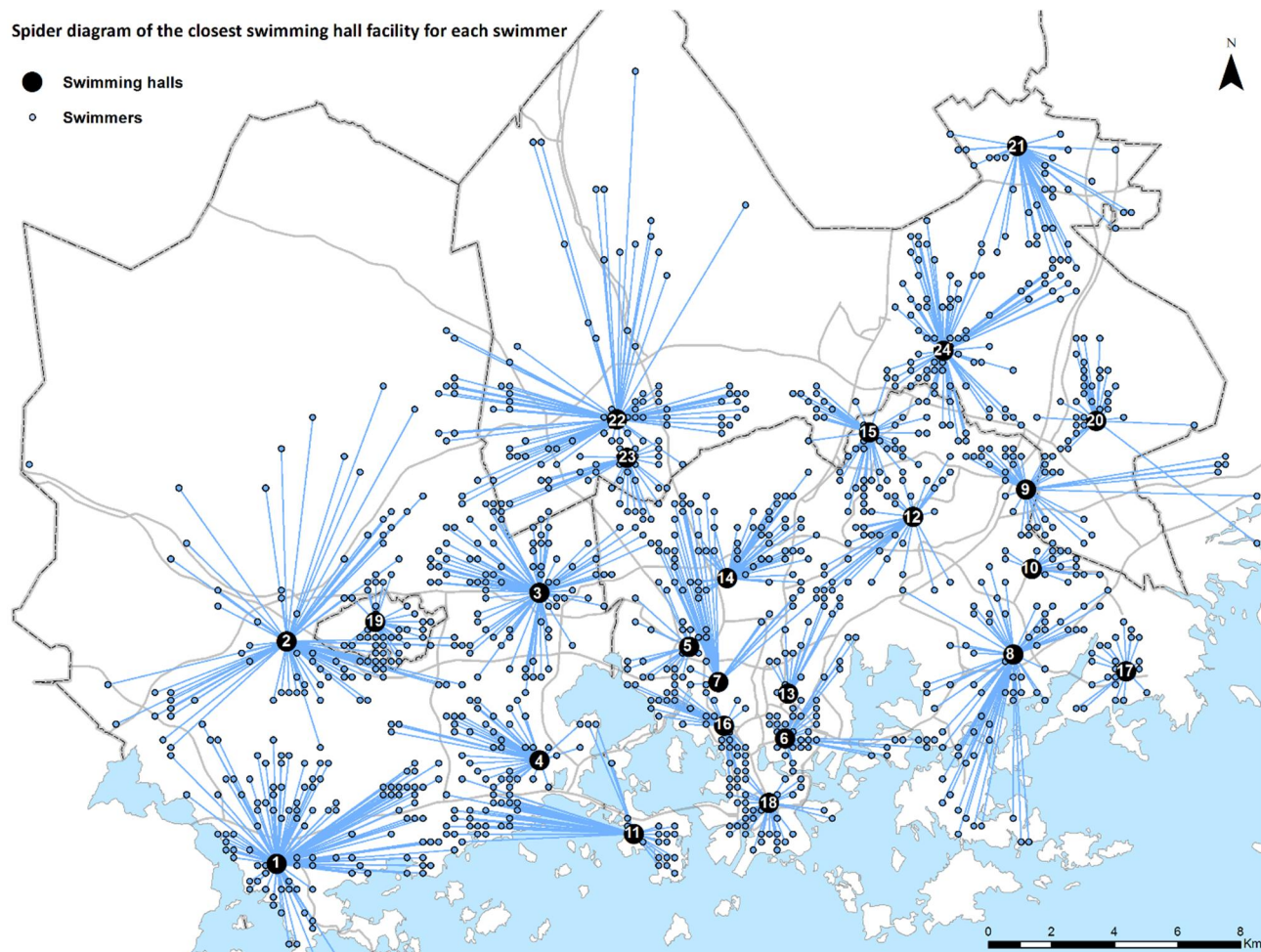
**Table 1S.** The total amount of swimmers and population (based on the YKR Grid data) inside the 10 and 20 minute service areas for PT, car and walking. The service areas for each travel mode are derived from the Travel Time Matrix.

Swimming pool	ID	Swimmers 10 PT	Swimmers 20PT	Swimmers 10 Car	Swimmers 20 Car	Swimmers 10 Walking	Swimmers 20 Walking	Population 10PT	Population 20PT	Population 10 Car	Population 20 Car	Population 10 Walking	Population 20 Walking
Hakunila	20	6	36	17	124	6	17	2643	13052	5091	60694	2643	8771
Korso	21	3	6	10	85	3	5	626	6239	12236	57965	626	6062
Martintaaiko	22	10	53	19	277	8	29	4204	23008	7226	151372	3621	16341
Myrämäki	23	17	57	44	423	17	42	5831	23937	16054	253248	5831	16729
Tikkurila	24	10	51	42	245	10	35	3483	22179	19514	137606	3483	17531
Kauniainen	19	9	50	6	147	8	38	904	8360	25799	57827	818	5449
Espoonlahti	1	1	31	60	266	1	22	854	18101	11542	142380	854	12957
Keski-Espoo	2	0	15	5	288	0	2	2293	13931	11542	142380	2293	7792
Leppävaara	3	6	21	20	404	6	21	2337	13316	10645	217810	2337	12480
Tapiola	4	6	17	4	307	6	9	2764	13304	2980	194235	2764	10068
Haaga	5	7	58	42	629	7	26	6013	51347	31302	442116	6012	19315
Invalidisäätö	6	0	17	13	498	0	13	1864	23507	14998	388204	1864	16055
Itäkeskus	7	2	20	17	327	1	8	2755	28677	20233	330844	1545	11135
Jakomäki	8	1	33	17	403	0	7	2936	26879	11454	298715	1718	7542
Kontula	9	5	48	11	174	5	17	7401	54164	11926	182346	7401	22257
Lauttasaari	10	5	23	21	319	5	20	3650	17067	16120	227372	3650	11487
Malmi	11	1	39	20	359	1	16	2801	30647	15427	288707	2671	12794
Mäkelänrinne	12	4	60	5	297	4	21	7216	72488	6362	285546	5873	23722
Pirkkola	13	0	21	13	448	0	13	442	20511	7707	315531	442	9383
Siltamäki	14	8	23	28	351	8	17	3051	14533	16345	210120	2838	9159
Töölö	15	30	111	51	504	15	44	14284	75149	36672	402555	8820	23300
Urheilutalo	16	12	65	47	421	12	32	21242	79920	56416	373750	18437	44294
Vuosaari	17	9	32	17	101	9	23	7836	37570	20697	120666	7836	26027
Yrjönkatu	18	5	89	59	390	5	31	9577	113251	62798	332758	8650	41942
Maximum	-	Töölö (30)	Töölö (111)	Espoonlahti (60)	Töölö (504)	Myrämäki (17) Jakomäki, Pirkkola, Invalidisäätö, Keski- Espoo, Vuosaari (0)	Töölö (44)	Urheilutalo (21242)	Yrjönkatu (113 251)	Yrjönkatu (62798)	Haaga (442116)	Urheilutalo (18437)	Urheilutalo (44294)
Minimum	-	Pirkkola, Invalidisäätö (0)	Korso (6)	Tapiola (4)	Korso (85)	Keski-Espoo (2)	21	Pirkkola (442)	Korso (6239)	Kauniainen (681)	Kauniainen (57827)	Pirkkola (442)	Kauniainen (5449)
Average	-	7	41	24	324	6	21	4875	33381	18343	233091	4293	16358
Median	-	6	35	18	323	6	21	2994	23258	15213	222591	2801	12876



**Table 2S.** The percentages of swimmers and population (based on the YKR Grid data) inside the 10 and 20 minute service areas for PT, car and walking. The service areas in minutes for each travel mode are derived from the Travel Time Matrix. Total population in 2013 in Greater Helsinki was 1 052 101 based on YKR grids and the total amount of swimmers was 1681.

Swimming pool	ID	Swimmers 10 PT	Swimmers 20PT	Swimmers 10 Car	Swimmers 20 Car	Population 10PT	Population 20PT	Population 10 Car	Population 20 Car
Hakunila	20	0,36 %	2,14 %	1,01 %	7,38 %	0,25 %	1,24 %	0,48 %	5,77 %
Korso	21	0,18 %	0,36 %	0,59 %	5,06 %	0,06 %	0,59 %	1,16 %	5,51 %
Martinlaakso	22	0,59 %	3,15 %	1,13 %	16,48 %	0,40 %	2,19 %	0,69 %	14,39 %
Myyrmäki	23	1,01 %	3,39 %	2,62 %	25,16 %	0,55 %	2,28 %	1,53 %	24,07 %
Tikkurila	24	0,59 %	3,03 %	2,50 %	14,57 %	0,33 %	2,11 %	1,85 %	13,08 %
Kauniainen	19	0,54 %	2,97 %	0,36 %	8,74 %	0,09 %	0,79 %	0,06 %	5,50 %
Espoonlahti	1	0,06 %	1,84 %	3,57 %	15,82 %	0,08 %	1,72 %	2,45 %	11,58 %
Keski-Espoo	2	0,00 %	0,89 %	0,30 %	17,13 %	0,22 %	1,32 %	1,10 %	13,53 %
Lepävaara	3	0,36 %	1,25 %	1,19 %	24,03 %	0,22 %	1,27 %	1,01 %	20,70 %
Tapiola	4	0,36 %	1,01 %	0,24 %	18,26 %	0,26 %	1,26 %	0,28 %	18,46 %
Haaga	5	0,42 %	3,45 %	2,50 %	37,42 %	0,57 %	4,88 %	2,98 %	42,02 %
Invalidisäätiö	6	0,00 %	1,01 %	0,77 %	29,63 %	0,18 %	2,23 %	1,43 %	36,90 %
Itäkeskus	7	0,12 %	1,19 %	1,01 %	19,45 %	0,26 %	2,73 %	1,92 %	31,45 %
Jakomäki	8	0,06 %	1,96 %	1,01 %	23,97 %	0,28 %	2,55 %	1,09 %	28,39 %
Kontula	9	0,30 %	2,86 %	0,65 %	10,35 %	0,70 %	5,15 %	1,13 %	17,33 %
Lauttasaari	10	0,30 %	1,37 %	1,25 %	18,98 %	0,35 %	1,62 %	1,53 %	21,61 %
Malmi	11	0,06 %	2,32 %	1,19 %	21,36 %	0,27 %	2,91 %	1,47 %	27,44 %
Mäkelänrinne	12	0,24 %	3,57 %	0,30 %	17,67 %	0,69 %	6,89 %	0,60 %	27,14 %
Pirkkola	13	0,00 %	1,25 %	0,36 %	26,65 %	0,04 %	1,95 %	0,73 %	29,99 %
Siltamäki	14	0,48 %	1,37 %	1,67 %	20,88 %	0,29 %	1,38 %	1,55 %	19,97 %
Töölö	15	1,78 %	6,60 %	3,03 %	29,98 %	1,36 %	7,14 %	3,49 %	38,26 %
Urheilutalo	16	0,71 %	3,87 %	2,80 %	25,04 %	2,02 %	7,60 %	5,36 %	35,52 %
Vuosaari	17	0,54 %	1,90 %	1,01 %	6,01 %	0,74 %	3,57 %	1,97 %	11,47 %
Yrjönkatu	18	0,30 %	5,29 %	3,51 %	23,20 %	0,91 %	10,76 %	5,97 %	31,63 %



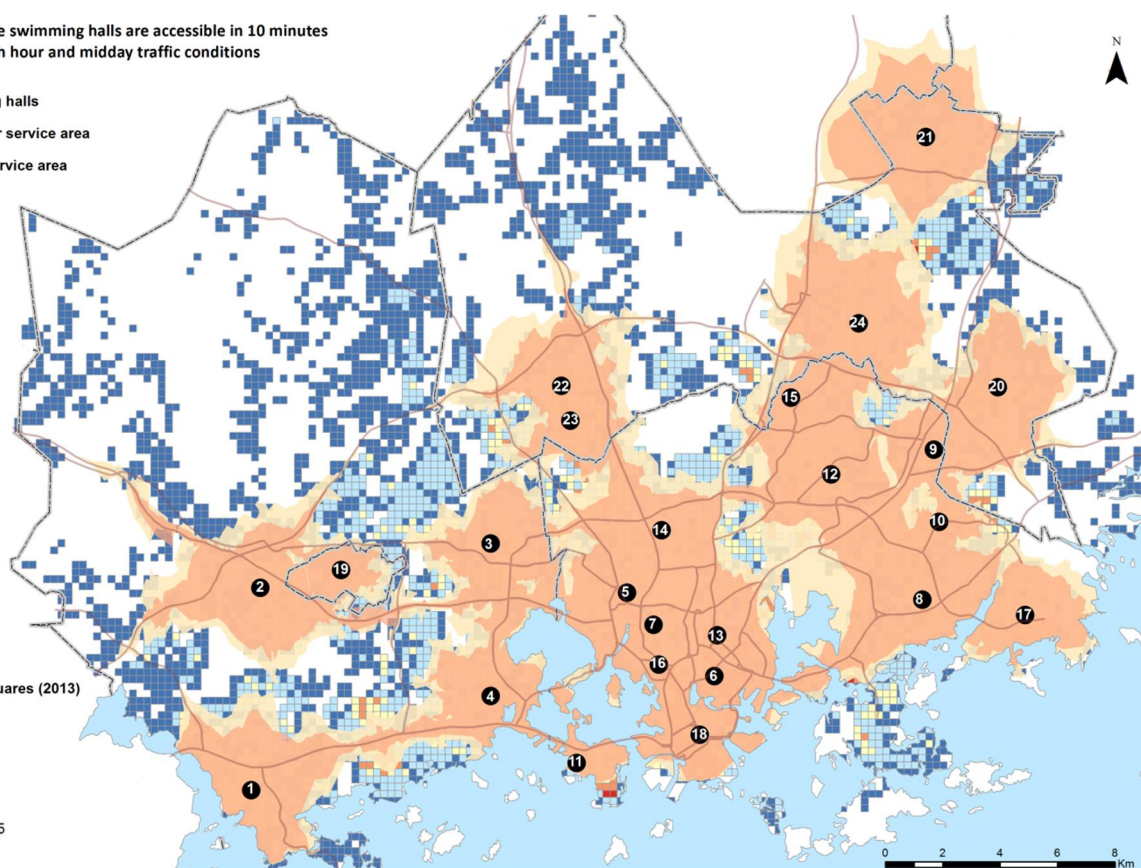
**Figure 1S.** Spider diagram showing the closest swimming hall for each swimmer. The calculation was made using the MetropAccess Digiroad tool 4.

Areas from where swimming halls are accessible in 10 minutes  
by car during rush hour and midday traffic conditions

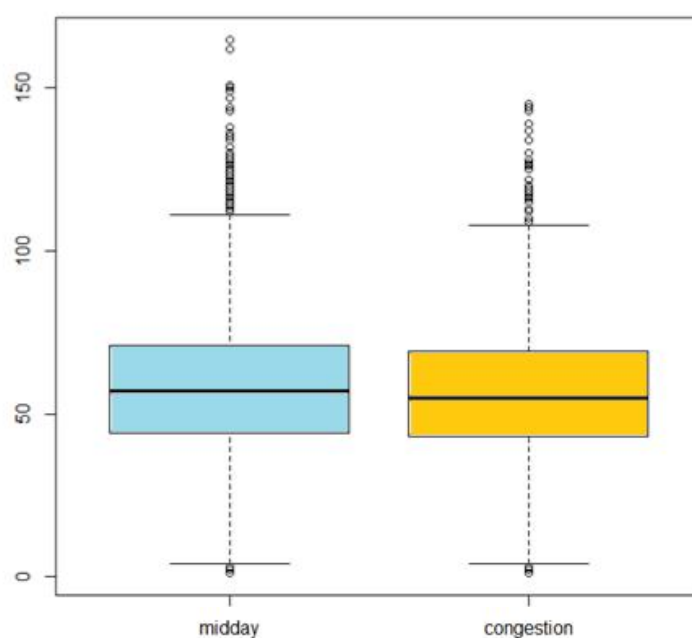
- Swimming halls
- Rush hour service area
- Midday service area

Inhabited grid squares (2013)

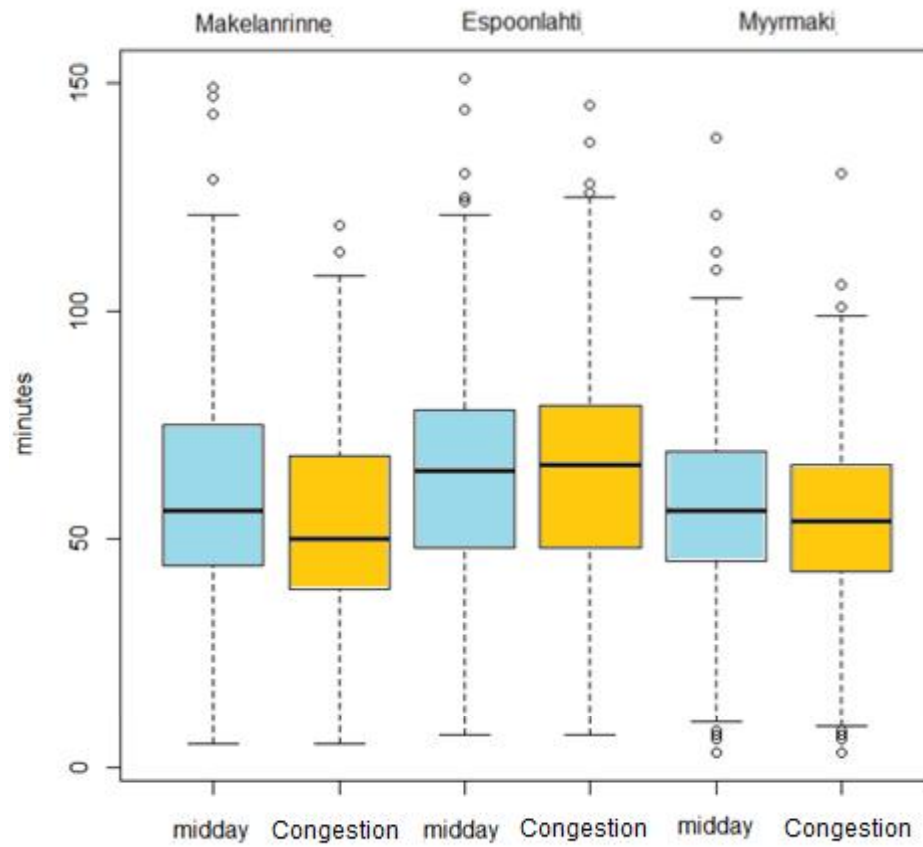
- 0 - 85
- 86 - 282
- 283 - 575
- 576 - 1068
- 1069 - 2805



**Figure 2S.** Areas from where swimming pools are accessible by private car during rush hour and midday traffic conditions in 10 minutes. The service areas were calculated using the SA-tool (Digiroad).



**Figure 3S.** Travel times (in minutes) from active swimmers' homes to all 24 swimming pools by PT during midday (12.00) and during rush hour (17.00).



**Figure 4S.** Travel times (in minutes) from active swimmers' homes to three selected swimming pools (Mäkelänrinne, Espoonlahti and Myyrmäki) by PT during midday (12.00) and during rush hour (17.00).

# Accessibility to nationally important museums

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## 1 Introduction

In this study we will look in the topic of accessibility and museums in the Helsinki Metropolitan Area. We wanted to find out if the area provides an adequate accessibility level to its inhabitants to visit museums. As we will show, museums are important places with multiple purposes. They provide a place for school groups to learn, for tourists to take a peek into the cultural heritage, and for all people to enjoy. This strong social significance underlines the need for all inhabitants to be able to access museums. This is also our main question in this study: How well is the accessibility of museums achieved in the Helsinki Metropolitan Region?

### *Background*

The International Council of Museums (ICOM) (2014) has defined a museum as a “non-profit, permanent institution in the service of society and its development, open to the public, which acquires, conserves, researches, communicates and exhibits the tangible and intangible heritage of humanity and its environment for the purposes of education, study and enjoyment”. In Finland the museum law states that the task of museums is to contribute to the availability of cultural and natural heritage. Museums should also record and maintain material and visual cultural heritage, pursue research related to the heritage, teach, communicate, organize exhibitions and produce publications (Suomen Museoliitto, 2014a).

According to the Finnish Museum Association (2014) museums can be listed under the following categories: cultural history museums, specialized museums, art museums, natural history museums and combination museums. The Museum Institute of Finland is divided into national museums, county museums, regional art museums and national special museums (Suomen museoliitto, 2014). Some museums, like the National Museum of Finland or Ateneum Art Museum, are museum monuments. These museum monuments exhibit the heritage and the art of the whole nation. Another type of museum is small specialized museums that focus on local cultural history or the life of a famous person. There are also outdoor museums that showcase old buildings and courtyards of different areas or eras. Some museums focus on special phenomena or artifacts (Suomen museoliitto, 2014b).

There are over 1000 museums in Finland. Out of these, 300 are open all year round and are maintained professionally (Suomen museoliitto, 2014a). In the capital region of Helsinki there are over 80 museums (Helsingin matkailu- ja kongressitoimisto, 2014). Most of the national museums, that is to say the national gallery museums (*Ateneum*, *Kiasma*, *Sinebrychoff*), *the National Museum of Finland* and *the Natural History Museum of Finland*, are located in Helsinki. Six out of 17 national special museums are also located in Helsinki (*the Museum of Architecture*, *the Design Museum*, *the Sport*



*Museum of Finland, the Finnish Museum of Photography, the Theatre Museum and the Museum of Technology*). One national special museum, *the Finnish Aviation Museum*, is one is located in Vantaa. (Museovirasto, 2014).

Accessibility can be defined as “*extent to which land-use and transport systems enable (groups of) individuals to reach activities or destinations by means of a (combination of) transport mode(s)*”(Geurs & van Wee 2004). Geurs & van Wee 2004 have also described four perspectives how accessibility can be identified. These are infrastructure based measures, normally used in transport planning. Location based measures means that accessibility is analysed at locations and this is normally used in urban planning and geographical studies. Person-based measures that means accessibility at the individual level and utility-based measures analyse mostly economic benefits.

### *Museum visits in 2013*



**Figure 1.** Museum visits in 2013 in the Helsinki Metropolitan Area (Museovirasto, 2013).

Most of the popular museums in Finland and in the capital region are located in Helsinki. In 2013, the most popular museum was *Ateneum Art Museum* (Figure 1). Almost all of the most popular museums are big national museums located in Helsinki, except for *EMMA* in Espoo. All of the most popular museums have an entrance fee, but they also offer free admission. For example all the national gallery museums are free of charge for children under 18, war veterans, journalists and therapy groups. In addition, they have a free evening once a month. *EMMA* has more free visits than paid visits. In *EMMA* also all over 70-year-olds have free entrance.

### *Museum accessibility*

According to Karvonen et al. (2007: 7) all the people living in Finland should be able to have access

to culture in spite of their age, gender, nationality, language, health, disability, social status or wealth. The equality of cultural services means equal rights and possibilities to participate and gain experiences. When one talks about accessibility in museums, it normally means that customers' needs should be taken into consideration in all museum activities and in every step of the museum visit (Museoliitto, 2014a). In Finland the association called *Yhdenvertaisen kulttuurin puolesta* has a webpage 'Culture for All' that gives consultation to cultural institutions about accessibility issues. On this web page accessibility is regarded as attitudes, accessible communications, accessible pricing, the accessibility of the build environment, sensory access, intellectual access, social and cultural access and policies as well as action plans (Culture for All, 2014). These all need to be considered if cultural institution wants to be accessible. However, Culture for All does not take into account how the building itself is physically accessible by car, public transport or walking. Most museums take this into account on their web pages and brochures and tell how the museums can be accessed.

Besides every citizen's right to get to know one's own culture and history, museums have social significance to society. Museums contribute to lifelong learning and increases the development of different talents. Museums co-operate with schools, scientific and private institutes and mental health institutions. Museums for example organize educational programs and projects. This kind of cultural education is important regarding for example children's development. Museum environments are pleasurable and relaxing. Often museums have a café or a restaurant and they can be places of social activity. Museums stimulate imagination and allow people to make new discoveries. Museums are also places of peace and serenity (Netherland Museum Association, 2011).

## 2 Data and methods

There are many museums around the region, but in our study we focus on the nationally important museums. They are important on a national level as cultural centres, as well as they are the ones with most visitors (Figure 1). The nationally important museums are *Ateneum*, *Kiasma*, *Sinebrychoff*, *the National Museum of Finland*, *the Natural History Museum of Finland*, *the Museum of Architecture*, *the Design Museum*, *the Sport Museum of Finland*, *the Finnish Museum of Photography*, *the Theatre Museum* and *the Museum of Technology* and *the Finnish Aviation Museum*. On top of these we decided to include *the museum of modern art (EMMA)* located in WeeGee-house in Tapiola. The house has a special purpose as a cluster of museums and *EMMA* is one of the most popular museums of Finland. Most of the study museums are located in Helsinki, but as one nationally important museum is located in Vantaa (the Aviation Museum), we also wanted to include one in Espoo. For the purpose of our public service point-of-view, galleries were left out of the sample for they usually do not operate on a non-profit basis.

For our analysis we compared two different time-based accessibility approaches based on public transportation and car for the selected museums that are listed in Table 1. We wanted to see how many people can reach selected museums in certain time and how the selected transportation reflects to that. For comparison we selected travel times 30 and 60 minutes by public transportation and 30 minutes by car. We decided not to include 60 minutes travel time by car for the results, because according to our analysis it is possible to reach from any location in the study area to some of the



museums in this time.

Location of the museums was collected from the Helsinki Service Map 2014 that contains information of the different services in Helsinki Metropolitan Area. Some missing museums from the site (Espoo museum of modern arts (EMMA) and Finnish Aviation museum) were manually located from the map. All the locations were converted to points compatible in ArcGis 10.2 for further analyses.

**Table 1.** Selected museums, their types and locations.

Type of Museum	Name	City
National Gallery Museums	Ateneum	Helsinki city center
	Kiasma	Helsinki city center
	Sinebrychoff	Helsinki city center
National Museum of Finland	National Museum of Finland	Helsinki Töölö
Natural History Museum	Natural History Museum	Helsinki city center
Special Museums	Museum of Architecture	Helsinki Kaartinkaupunki
	Design Museum	Helsinki Kaartinkaupunki
	Sport Museum of Finland	Helsinki Töölö
	Finnish Museum of Photography	Helsinki Ruoholahti
	Theatre Museum	Helsinki Ruoholahti
	Museum of Technology	Helsinki Vanhankaupunginlahti
	Finnish Aviation Museum	Vantaa
Espoo Museum of Modern Art	Espoo Museum of Modern Art	Espoo

Locations of the museums were generalized to 250 m x 250 m grid cells so that we could use the

Travel time matrix. Calculated travel-times are so called overall travel-times (door-to-door) including time spent to walking to the car and finding a parking lot and possible waiting time in home when using public transportation.

Analyses were done using Python-tool that was based to the code from Henrikki Tenkanen from the University of Helsinki. Code locates travel times using travel time matrix to the museums from every grid in Helsinki Metropolitan Area. Overlaying the output layers provides possibility to point out all the areas from where it is possible to reach the museums in given time. After identifying so called service areas, sum of people living inside the service area was calculated using YKR 2013 population data as these people can be seen potential users of the museum services.

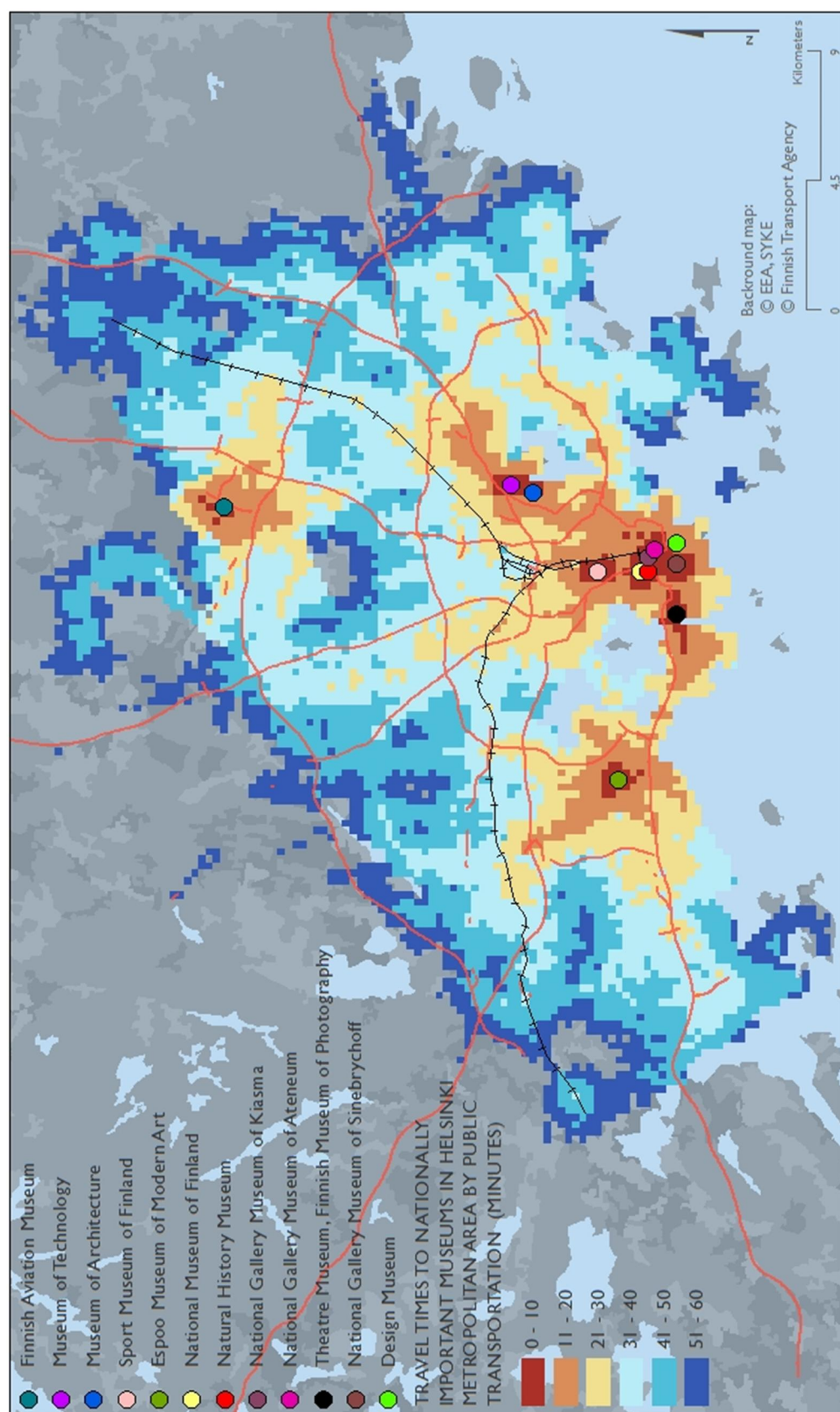
### 3 Results

We analysed the possibilities to reach 13 nationally important museums. The goal was to see how these museums can be reached in given time using public transportation and car. As we can see from the Table 1 almost all the museum are located in Helsinki. The city centre area dominates as an area where museums are located. Also the museums on Kaartinkaupunki and Töölö are very close to city centre. Basically outside this area are museum that are located in cultural centre Kaapelitehdas in Ruoholahti and museum of technology in Vanhankaupunginlahti whose location is explained by historical reasons.

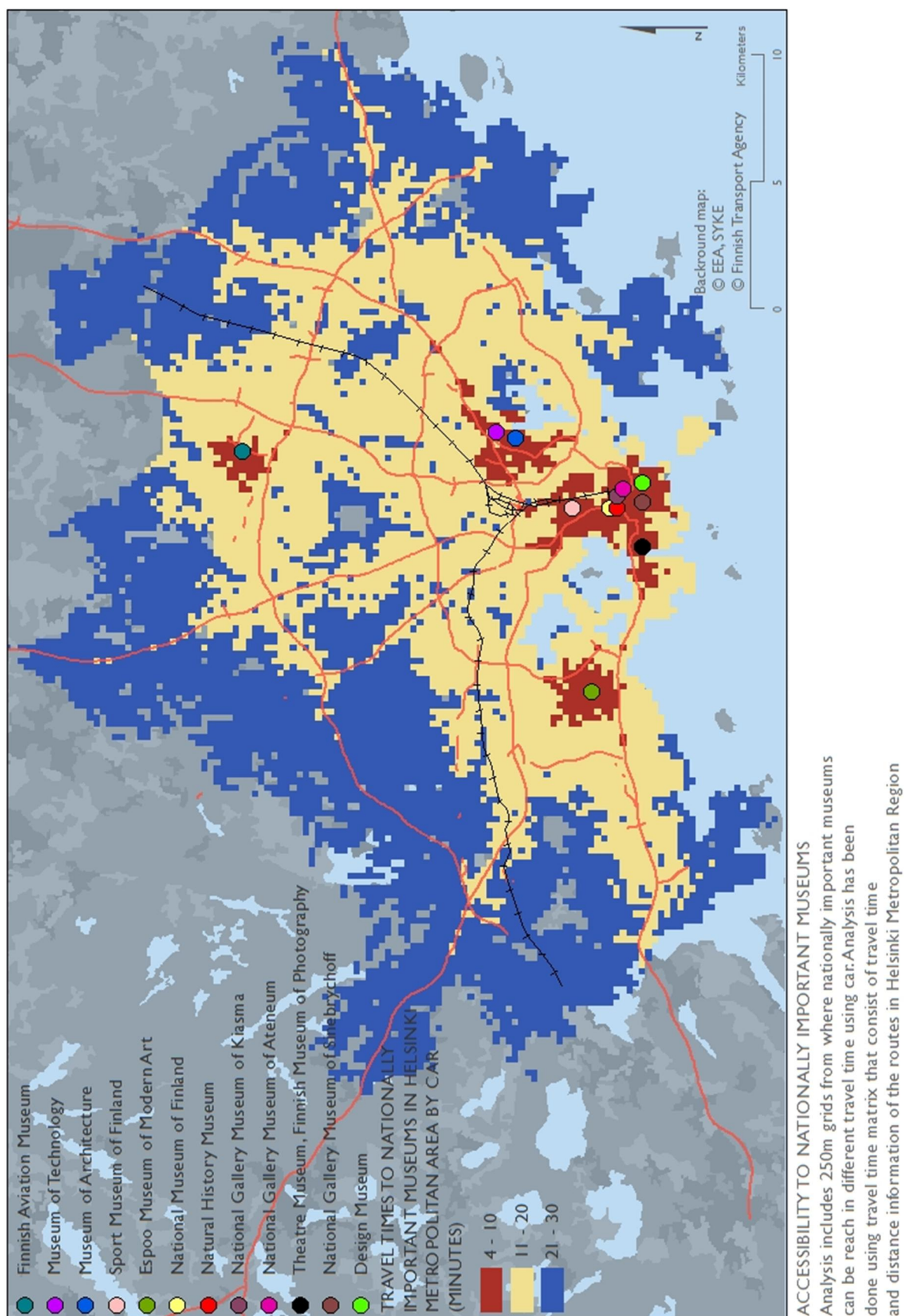
The 30-minute time frame with public transportation shows the impact of rail lines in the accessibility (Figure 2). From areas close to metro or railway stations it is possible to reach a museum in this time. The Helsinki city centre has a good level of accessibility to many museums in an adequate time, as most of the nationally important museums are located there.

The impact of level of service of public transportation is clearly seen in the case of the Aviation museum in Vantaa. The possibility to access it in half an hour is from drastically smaller area than for example EMMA in Tapiola. Large areas of Vantaa are outside of reach in this map, because most of the museums are located elsewhere, but also because of the public transportation service. It also shows the lack of east-west -link services, for the northern and eastern parts of Helsinki and western parts of Espoo remain inaccessible from the museums within half an hour. There are 438072 inhabitants living inside 30 minutes service area (YKR, 2013) that can be seen potential users of the museum services. This would mean approximately 40 % of the entire population.

In a 60-minute time frame the accessibility area increases with the public transportation (Figure 2) from north to south and east to west. Northern Espoo and Vantaa are still mostly inaccessible, but as we seen in Figure 4 there are not much population living in these areas. There are 1025496 inhabitants inside this service area (YKR, 2013) which is approximately 93 % of the entire population of the area.

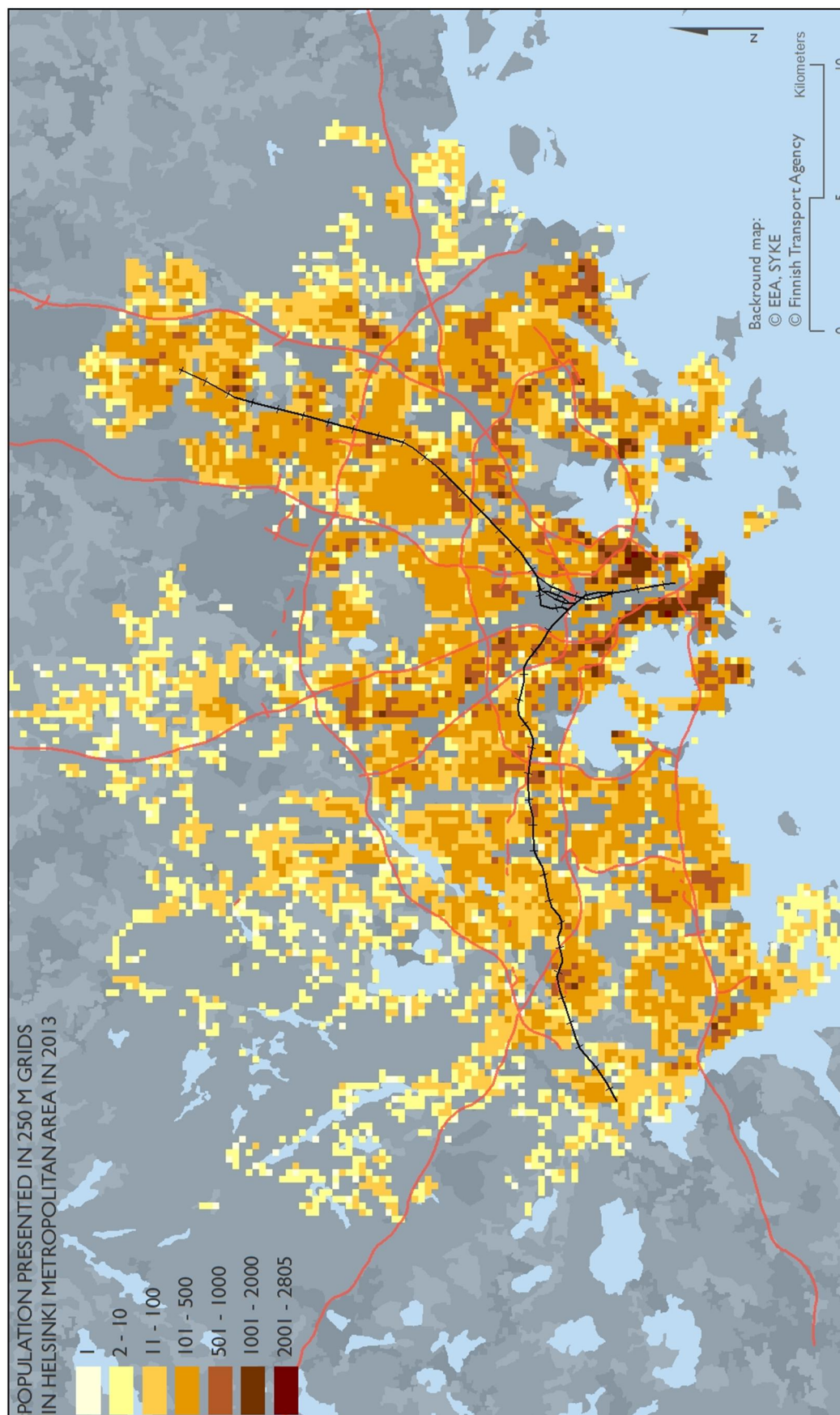


**Figure 2.** Accessibility to nationally important museums by public transportation with a 60-minute time frame.



**Figure 3.** Accessibility to nationally important museums by car with a 30-minute time frame.





**Figure 4.** Population in Helsinki 2013.

By car the accessibility was measured only with 30 minutes. As we see from Figure 3 it covers larger area compared to 60 minutes by public transportation. Vantaa is now mostly accessible, but large portion of Northern Espoo remains inaccessible. There are 1039016 inhabitants inside this service area (YKR, 2013) which is approximately 94 % of the entire population of the area.

#### **4 Discussion and conclusions**

Overall, it can be said that the accessibility to the museums by car in 30 minutes and by public transportation in 60 minutes is good in the Helsinki Metropolitan Area. In terms of inhabitants, this means that almost all of the Metropolitan Area citizens can access museums in these time frames. Still, a larger proportion of inhabitants can reach a museum by car in 30 minutes than by public transportation in 60 minutes. Especially in Northern Espoo and Vantaa, areas that are not next to rails, car is faster transportation method.

In our study half an hour is the limit of adequate accessibility. This is not based on specific research, as it is hard to determine the time that people are willing to travel to a museum. It is depended on variables such as the current exhibition in a particular museum. Hence we decided to choose 30 minutes as the borderline. Within this limit of 30 minutes the accessibility with public transportation is not complete. Many parts of the study area are out of the accessibility range. For example Malmi in the northern Helsinki, is out of reach. Malmi has been planned as one of the regional center of the Helsinki Metropolitan Area.

The cultural services consist of Malmitalo that hosts various concerts. In terms of museums, we can say that Malmi is under-served. Adding a nationally important museum would increase the livelihood of the inhabitants of Malmi, but also of other northern parts of Helsinki would be served. Improving Malmi's museum services would also have an impact on the inhabitants of Vantaa, for Malmi is a public transportation hub to various directions.

For example the concept of WeeGee- house in Tapiola, with various museums in a cultural house, has proven to be working measured with popularity. The modern art museum EMMA situated in the WeeGee-house is the fourth most visited museum in the Greater Helsinki region in 2013 (Museovirasto, 2014). Other option could be to improve the areas brand was to set a tourist destination there, e.g. Guggenheim. Surely it could be done with less objection as now in Eteläranta.

Also areas in the western Espoo and many parts in Vantaa lack accessibility to nationally important museums. The opening of Länsimetro would increase the accessibility from western parts of Espoo and eastern parts of Helsinki towards for example the WeeGee -house in Tapiola. The plans of Jokeri-lines to improve the public transportation from east to west would also have an impact on accessibility, especially in the corridor of lower accessibility that is visible in the 30-minute time frame by public transportation. These plans have not been taken into account in our analysis, but will surely improve the situation of the poorly served areas.

As we can see from the accessibility maps with public transportation, the rail connections play an important role. We can thus say that adding rail connections especially in the east-west directions would highly increase the accessibility in the areas that are now low accessibility. Future research could investigate the coming plans of Länsimetro, Kehärata and the two possible Jokeris and their

impact on accessibility. Also an interesting research could be made with the change of the airport area of Malmin kenttä will changed to a housing neighborhood. If a nationally important museum was set there, the accessibility to museums from the parts lacking it now with the 30-minute time frame with public transportation might improve in many parts of the now under-served areas.

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# Analysing multimodal accessibility of Kela in Helsinki Region

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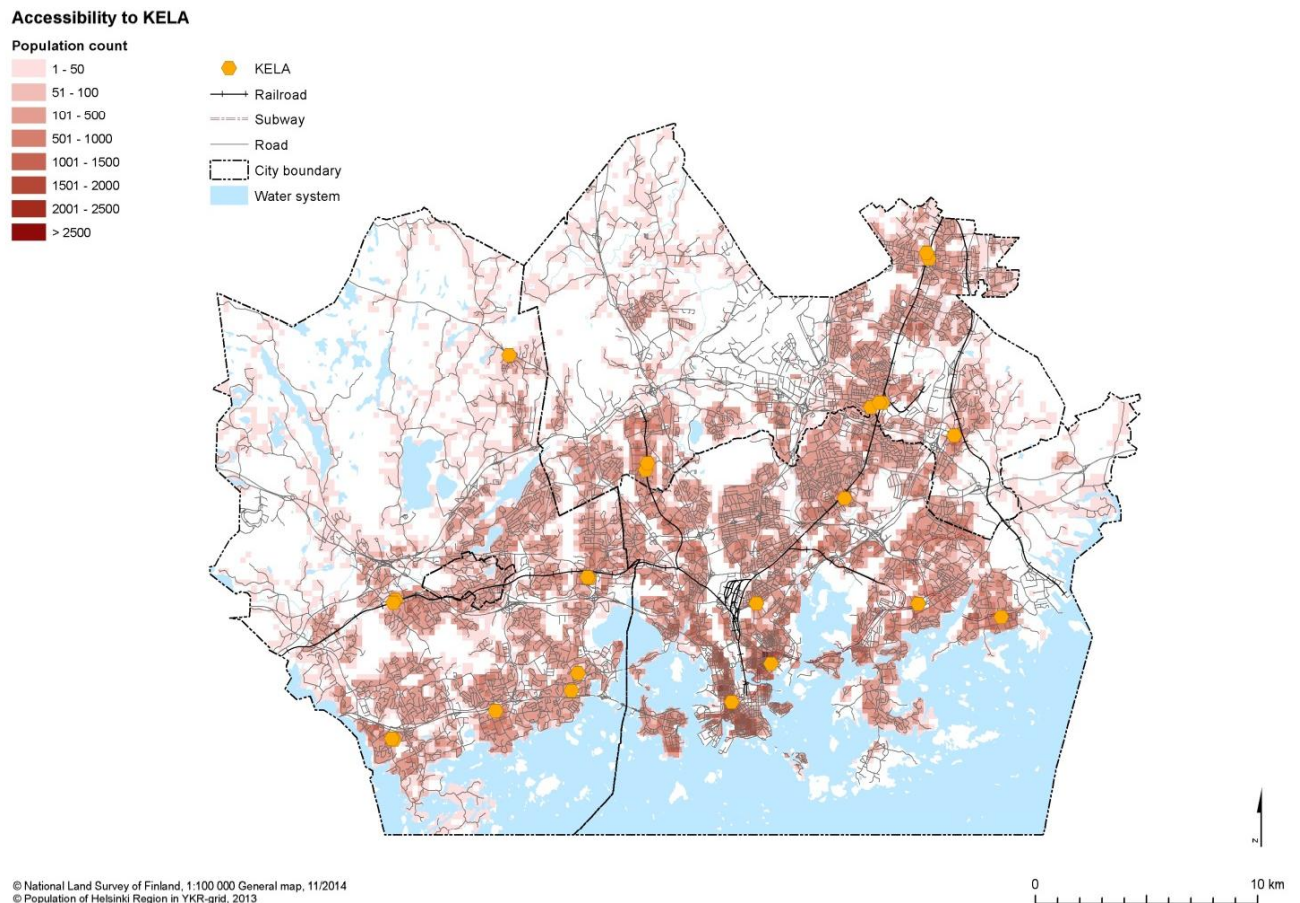
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## 1 Introduction

The equity of access to public services is a theme that is of great interest to both public service planners and researchers. Questions of spatial equity and equity in access to services in urban areas has evoked research in order to define measurements for equal access (eg. Tsou et al., 2005). In this study we examine more closely the accessibility of an important service: the Kela offices in the Helsinki region. Many of Kela's functions can nowadays be found online, and this has undoubtedly reduced the need to actually travel to the office. However, Kela is an important governmental organ especially for those who find themselves in challenging situations in their lives: students, retirees, those on long sick leaves, mothers and fathers with children, and handicapped, to name a few. If one doesn't know what to look for in the online service or how to fill out documents, it often is necessary to visit the office in person to get assistance and information. This is where the concept of multimodal accessibility comes into picture. The clientele of Kela might often have only a restricted access to private car, or none at all. In these cases good access to Kela by public transportation or walking is very important. The results from the accessibility analysis of certain Kela offices with certain traffic modes, give us not only important facts about the urban and traffic structure of Greater Helsinki, but also important information on how socially equal the structure or the system is to different users. In our study we are particularly considering this point of view.

When examining Kela offices and their locations with respect to other similar services (etc. employment agency) one can also make notions and some rough conclusion about the population structure of its area. In our research, Kela offices and employment agencies seem to be located in those areas, which are both sub regional centres of Greater Helsinki and concentrations of immigrants, city tenements, and higher unemployment compared to other areas nearby (Figure 1). These areas are for example Malmi, Itäkeskus, Vuosaari, Leppävaara and Espoo Centre. Examining the Kela offices also gives much information about regional development of different areas in Helsinki Region and the growth of Helsinki metropolitan area towards the suburban periphery – in a sense of expansion.



**Figure 1.** Population in Helsinki region by 250 m grid cells in relation to Kela offices.

## 2 Data and methods

### *Data acquisition and preparation*

To analyse the multimodal accessibility of Kela offices in Helsinki region we used an open dataset provided by the municipalities of the region (Palvelukartta, 2014). It lists a myriad of different services and their exact locations as point data. It is also possible to export the location points as KML-files. We did this to export the locations of the Kela offices in Helsinki, Espoo and Vantaa. There are currently no Kela offices in Kauniainen. For some reason the exportation only succeeded when done separately for each municipality, so the result was three different KML-files.

Next the KML-files were imported into ArcGis environment. To be able to operate with them they were first converted into geodatabase-files with the ArcToolbox tool “conversions/KML to layer”. They also needed a clean-up, since the search function of the service database had included some irrelevant rows, eg. recycling stations, in our data. There were some offices that were included twice, and these were deleted. We decided, however, to include offices under the same name (eg. Espoonlahti) but different address, because this means their actual location is also slightly different and therefore needs to be taken into account. Finally the three tables were merged into one with the ArcToolbox tool “general/merge”.

Another open dataset we used for the analysis was the Helsinki region travel time matrix (MetropAccess, 2014). It contains information about travel times from every single YKR-grid cell to every other cell by private car, public transportation and walking.

We decided to analyse the accessibility of Kela service network by allocating every grid cell their nearest office (in travel time). First we identified those YKR-grid cells that contain a Kela office. For that we downloaded the YKR-grid shapefile with population data (Population of Helsinki Region in YKR grid 2013) and imported it into ArcGIS. Then the cells containing a Kela office were identified by using the select by location-tool.

For the closest office-allocation we used two python scripts developed by Henrikki Tenkanen. We created an input text file containing the YKR IDs of the origin points and destination points, origin points being all the YKR grid cells and destination points being the cells containing a Kela office. This was fed to a script that created an output csv-file where each row represented a relation from each origin point to each destination point. This csv file was then fed to another script that determined the closest destination point for each origin point. The output-csv-file could then be imported into ArcGIS and visualised.

### *Data visualisation*

The files were imported to ArcMap and they were joined with the YKR-grid shapefile. First we joined a file that contained travel times and distances of private car to a similar file of public transportation. These two files were joined by field from\_id. After this joining we joined this private car text file containing public transportation data to the YKR-grid shapefile. These two files were joined by using the YKR grid cell ID's in the files. From joining options we chose option *keep only matching records*. After joining we exported the data and reimported it to ArcMap. To this new shapefile we added new field where we calculated the differences of travel times between private car and public transportation. Before visualising the accessibility of these three travel modes we needed to join a data file with walking information to the YKR-grid shapefile. Before joining these two files we needed to remove the joining of private car text file and replace it with file of walking information.

Accessibility to the closest Kela office was visualised by travel times of private car, public transportation and by walking. Travel time was classified to six classes and the maximum value was 60 minutes. When a difference of private car and public transportation was presented travel time differences were classified to seven classes. To a map that presented travel times by walking we added a three kilometres buffer around to each Kela office. The function of these buffers was to ease the understanding of a distance from where Kela offices were reached by walking. To all visualisation we also added the traffic route network and administrative borders from the general map 1:100000 dataset provided by National Land Survey of Finland.

To analyse how many people have access to a Kela office within various time windows we used the YKR-population data. We calculated travel times for each transport mode separately: private car, public transportation and walking. This was done in ArcGIS by querying cells by their travel times and using the statistics-tool to count the population within these cells. The population count is done for the whole population, as we did not have the population data by age groups.

### 3 Results

In total there are twenty-four Kela offices within Helsinki Region. Six offices are located in Helsinki, ten in Espoo and eight in Vantaa. Accessibility to the closest Kela office varies between the mode of transportations and by the location from where it is reached.

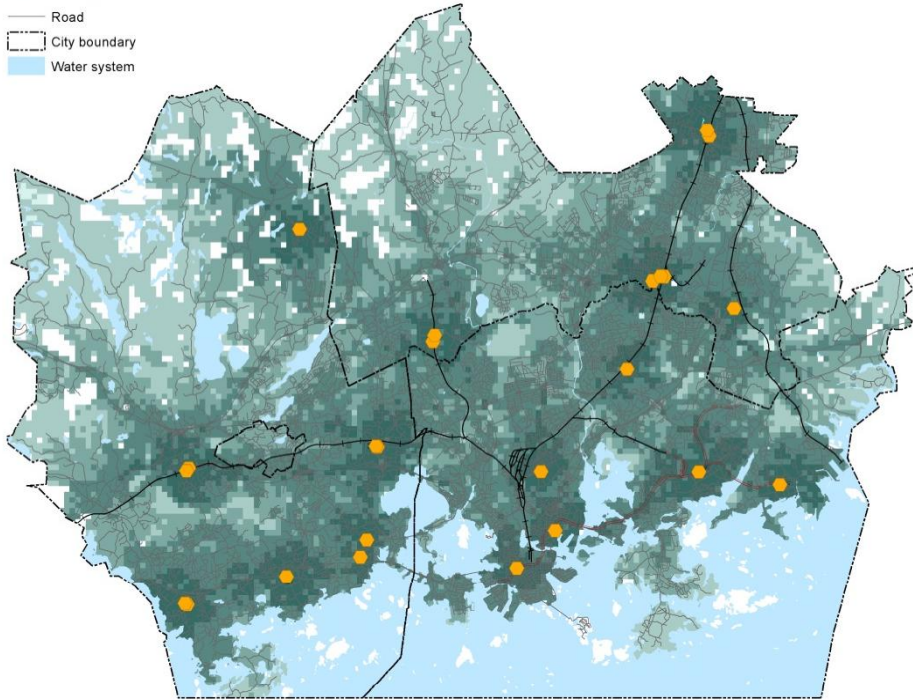
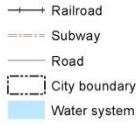
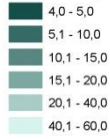
#### *Accessibility by private car in Helsinki Region*

Accessibility to the closest Kela office in Helsinki Region by private car is fairly good from every location within Helsinki Region (Figure 2). From nearly every location the travel time is 60 minutes or less. From most parts of Helsinki travel times varies between five and 20 minutes. Exceptions are Santahamina in southern Helsinki, and Östersundom in eastern Helsinki, from where the accessibility is weaker than from other locations. The travel time from these two places varies between 20 and 40 minutes. Even in 15 minutes it is possible to access to the closest Kela office by private car from a fairly large area of Helsinki. But when the maximum travel time is dropped to ten minutes the accessibility is limited to the vicinity of Kela offices.

In Vantaa the travel time to closest Kela office is 20 minutes or less from most parts of the city. Weakest accessibility is from the North-West of Vantaa. The travel time from there is 20 to 40 minutes to the closest Kela office. In Espoo the pattern is quite similar to that of Vantaa. Accessibility from the North-West of Espoo to the closest Kela office is 20 to 40 minutes and from other locations a travel time is 20 minutes or less. With ten to 15 minutes travel time the accessibility to the closest Kela office is broader than what it is with five to ten minutes travel time but still it is limited to the vicinity of the Kela offices.

### Accessibility to KELA

#### Travel time by car (min)



© National Land Survey of Finland, 1:100 000 General map, 11/2014  
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 (University of Helsinki), MetropAccess-YKR-grid, 11/2014

0 10 km

**Figure 2.** Accessibility to the closest Kela office by private car in Helsinki Region.

When traveling by private car, the travel time to the closest Kela office from almost every location at Helsinki Region was 60 minutes or less, by public transportation the area from where the closest Kela office is reached by the same travel time is more narrow (Figure 3).

Areas reached by public transportation vary between Helsinki, Espoo and Vantaa. In Helsinki almost every part is covered within 40 minutes. Only from Santahamina and from some locations in Östersundom the journey takes more than 40 minutes. In Östersundom there are even locations from where the travel time is more than 60 minutes. In Espoo and Vantaa the weakest accessibility by public transportation to the closest Kela office is in North-Western parts of Vantaa and Espoo. From these locations the travel time is 40 to 60 minutes or even more.

The area covered within forty minutes travel time by public transportation to the closest Kela office is quite wide. But when the travel time is limited to 20 minutes, the area that is covered is greatly narrower and is limited to the vicinity of Kela offices. It can be seen as some kind of cusp because with 15 minutes travel time or less the difference is not that notable.

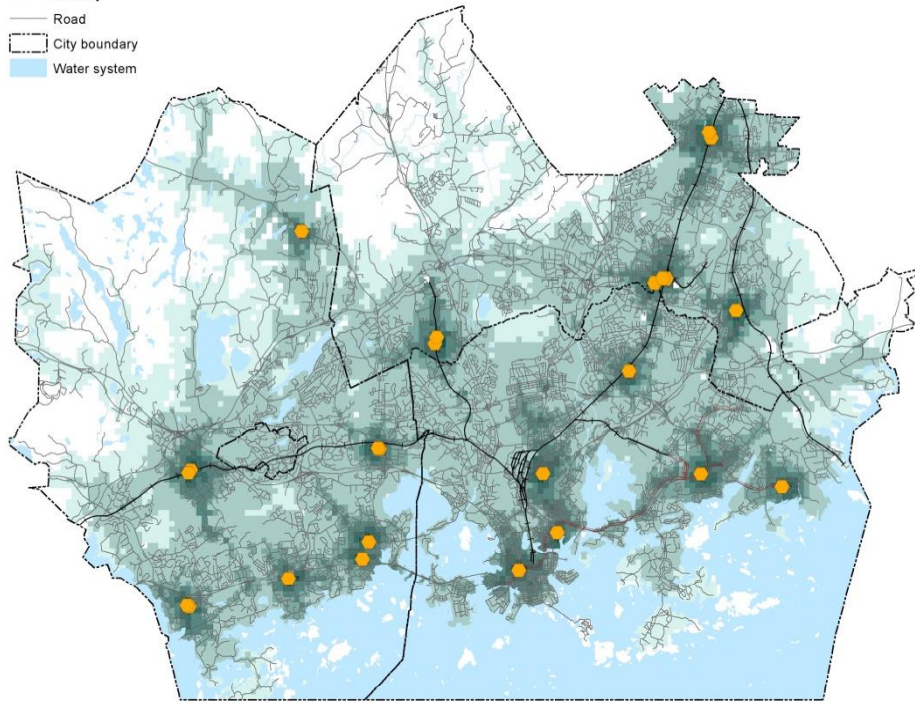


### Accessibility to KELA

Travel time by PT (min)

- 0,0 - 5,0
- 5,1 - 10,0
- 10,1 - 15,0
- 15,1 - 20,0
- 20,1 - 40,0
- 40,1 - 60,0

- Railroad
- Subway
- Road
- City boundary
- Water system



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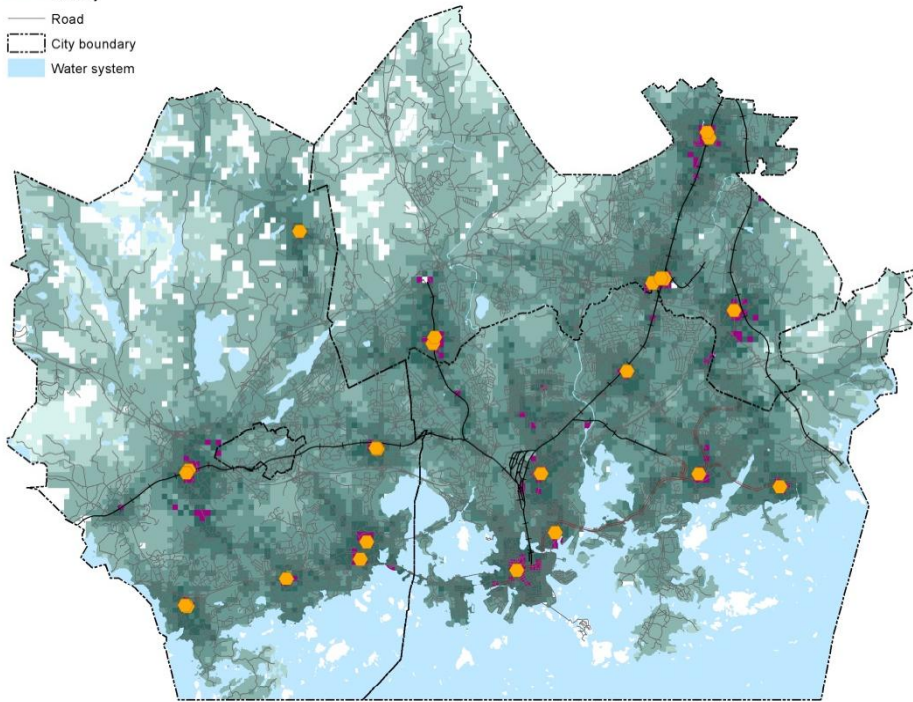
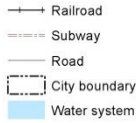
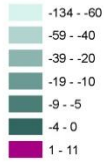
0 10 km

**Figure 3.** Accessibility to the closest Kela office by public transportation car in Helsinki Region.

When the travel times of the private car and public transportation are compared it is possible to notice that there are only few location where the accessibility by public transportation is better than by private car (Figure 4). Most of these locations are situated to the vicinity of Kela offices. From these locations public transportation saved travel time between one minute and 11 minutes.

#### Accessibility to KELA

Car and PT difference (min)



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 (University of Helsinki), MetropAccess-YKR-grid, 11/2014

0 10 km

**Figure 4.** Difference of the travel times by public transportation and by private car to the closest Kela office in Helsinki Region.

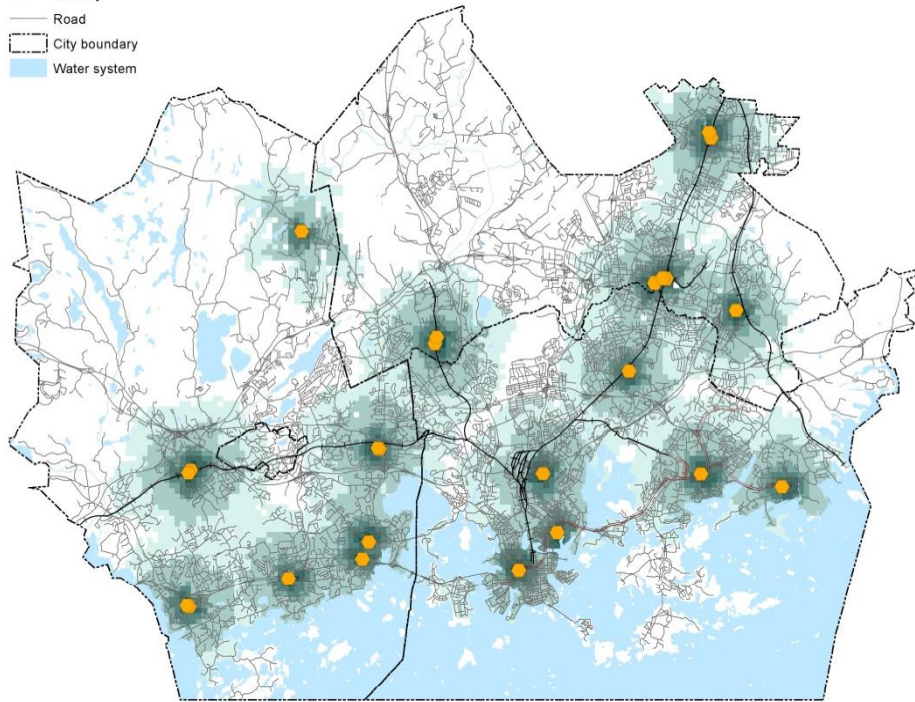
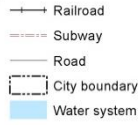
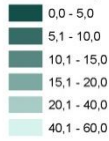
#### Accessibility by walking in Helsinki Region

By walking the accessibility to the closest Kela offices is limited to their vicinity in whole Helsinki Region (Figure 5). Within 60 minutes travel time it is possible to access to the closest Kela office from something like three kilometres distance. Even by walking the closest Kela office is possible to reach almost every part of the Helsinki in 60 minutes. The places from where a travel time is more than 60 minutes are situated in the southern, eastern and northern parts of Helsinki. These locations are Laajasalo, Santahamina, Östersundom and Pakila. In Vantaa the accessibility to the closest Kela office by walking in 60 minutes is possible from western and south-western parts of the city and from other locations a travel time is more than 60 minutes. In Espoo the accessibility by walking to the closest Kela office is best from the southern parts of the city and from other locations it takes more than 60 minutes to access the closest Kela office.



### Accessibility to KELA

Travel time by walking (min)



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0 10 km

**Figure 5.** Accessibility to the closest Kela office by walking in Helsinki Region.

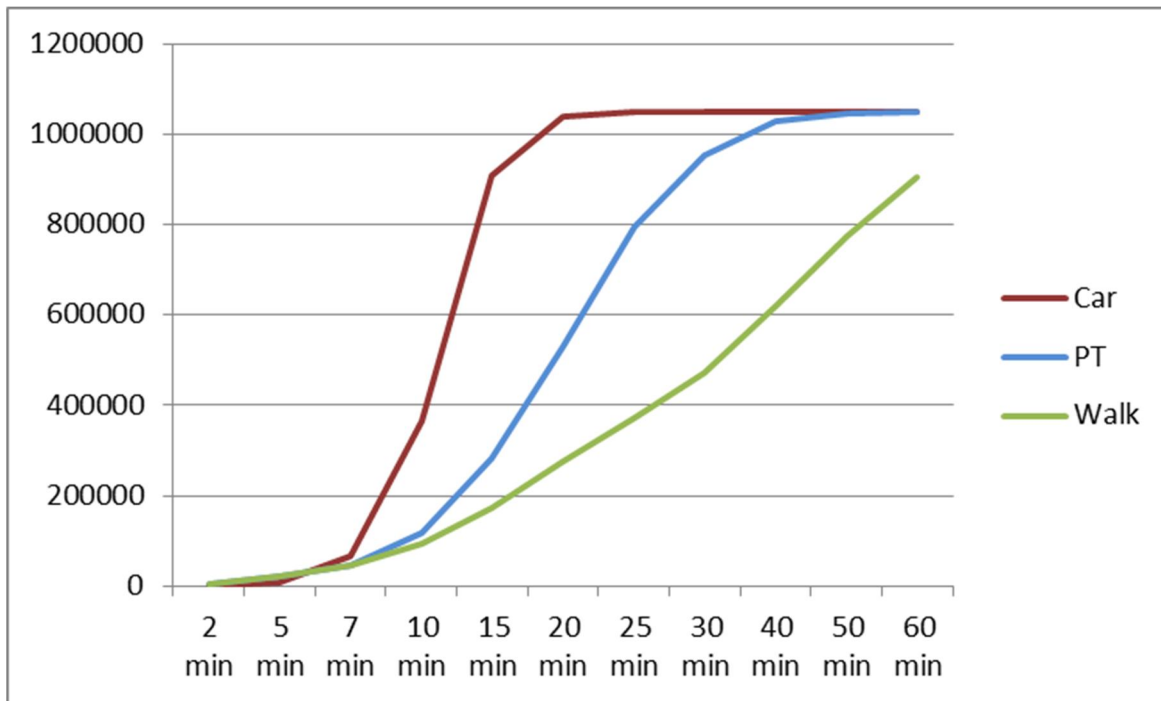
### *The share of population covered by different travel modes*

When analysing the number of people who have an access to a Kela office within different time windows, it can be seen that public transportation covers more people than private car on trips 5 minutes or shorter (Table 1.). The number of people whose travel time by walking is 5 minutes or less is exactly the same, however, which indicates that the travel time matrix for public transportation optimizes these trips to be done on foot. Based on the population data, the time window between 10 and 15 minutes seems to be the crucial turning point for private car, since the amount of people covered by this transportation mode increases more than twofold within this time. Over 86 % of the total population of Helsinki Region have access to Kela by private car within 15 minutes, and basically everyone in 20 minutes. For public transportation the biggest increase in population covered occurs between 20 and 30 minutes, from 50 % to 90 % of population covered.

**Table 1.** Number and share of people with an access to Kela within different time windows.

	Car	Car %	PT	PT %	Walk	Walk %
2 min	0	0	4850	0,5	4850	0,5
5 min	7656	0,73	23598	2,2	23598	2,2
7 min	66075	6,3	47232	4,5	47111	4,5
10 min	363929	34,6	117120	11,1	93983	8,9
15 min	909959	86,6	283264	27,0	174380	16,6
20 min	1039511	98,9	529580	50,4	274984	26,2
30 min	1050248	99,9	951681	90,6	473579	45,1
50 min	1050878	100	1044229	99,4	775090	73,8
60 min	1050878	100	1048323	99,8	904421	86,1
over 60 min	0	0	2555	0,2	146457	13,9

For private car, the amount of people covered increases drastically right after the 7 minute-mark, which can clearly be seen in Figure 6. For public transportation the share of people covered increases more slowly, and for a clear majority of people private car is therefore the quickest way to travel to a Kela office. It is also notable that almost up to 10 minutes public transportation and walking cover the same amount of people.



**Figure 6.** The share of people with an access to Kela within different time windows.

## 4 Discussion and conclusions

Before making any broader conclusion of our results, it is good to go through some thoughts about accessibility and especially think what good accessibility to public services means. According to the report by the Helsinki City Planning Department, those services which can be accessed in 5 to 10 minutes have a high ranking in terms of accessibility whereas services accessed in 30 to 40 minutes have a low ranking (Arjen saavutettavuus... 2013). In the Helsinki metropolitan region over 60 per cent of the population live in areas where the accessibility index of public transport is between these two ranks and only 11 per cent of the population in areas which can be accessed in less than 10 minutes by foot (Arjen saavutettavuus... 2013). Although there is a widely and internationally accepted definition for the limit zone of 500 meters' access to daily services, according to Kohijoki (2008) in a sparsely populated country, like Finland, a suitable distance to the nearest grocery can be one kilometre.

A good accessibility is not all about commonly accepted definitions or measurements – it is also determined by physical, psychical and economic factors (Kohijoki 2008). According to Ratvio (2012) people's decision whether to make a journey or not is highly dependent on their personal requirements, preferences (etc. accommodation) and the surrounding structure of physical environment. From this point of view a good accessibility to the Kela office can have a different meaning to different people. In our research, personal preferences or city structure are not the area of interest, but they are factors that eventually have great impact on people's travelling behaviour and along that, on used kilometres by car and greenhouse emissions. In general, we cannot think that people who most often need or use the Kela services are those people (retirees, handicapped etc.) that do not have a possibility to travel by car and that is why they are also reliant on a good access by foot or public transport. The people who do have a car are those who more often live in areas of small residential housing and who are not dependent on the vicinity of social services. All in all, in our results the significance of good access by foot or public transport (and not so much by car) is emphasized because the services offered by Kela offices are very seldom used every day and also because most of the services can be found on the internet and increasing amount of the population use electrical services.

As can be seen from the results, from the most part of Greater Helsinki travel times by car to the Kela offices are good (less than 20 minutes) and the North-West parts (in Espoo and Vantaa) are the only areas with worse (20 to 40 minutes) access to the offices. The same situation goes also with public transport. By looking at the locations of the areas with poorer accessibility by car, one can easily make notions that these areas aren't close to the main roads, which leads automatically to the conclusion that people living in these areas are highly dependent on cars. Distant locations and weak public transport network can also be reasons not to choose public transport mode to access the services. By looking at the accessibility by public transport, only the areas in the vicinity of the Kela offices can be accessed in less than 20 minutes. From the perspective of usability of public transport this is problematic since quite few people who often use these services live within this area. Although, it's more profitable to use public transport than car in this 20 minutes' area and generally in the centre areas because one doesn't need to spend time parking, subways and trains don't get stuck in traffic lights and public transport usually have their own lane which reduces travel time. From the results

(Figure 1 & 2) it can be noticed that the lack of transverse traffic routes weakens the accessibility of certain areas. One can argue that nowadays supply and demand don't intersect in transverse traffic, which makes some areas poorly accessed (Arjen saavutettavuus... 2013).

Based on our results it is not profitable to make a journey to the Kela offices by foot – except in the vicinity of them – because even in Helsinki, which has most the offices in respect of the area size, the travelling time may take up to 60 minutes. This notion is emphasized also in the report by the Helsinki City Planning Department: most of the journeys made by foot are five minutes, whereas 20 minute journeys are unusual (Arjen saavutettavuus... 2013). If we take into consideration these numbers and the fact that quite few people live in the areas where the nearest Kela office is within a five minutes' walk, three conclusions can be drawn. Firstly, the growth of the ageing population strongly affects the demand of local services in the near future. Secondly, poor accessibility by public transport or by walking most probably encourages car use in certain areas and among certain people. Thirdly, using public traffic to access the Kela offices and other services should be as efficient and easy to diminish the negative impacts of the previous two remarks.

To make final conclusions about the accessibility of the Kela offices in the Greater Helsinki, it is worthwhile to take into account the point mentioned earlier in the background – the expansion of the city area towards the suburban periphery. This development leads to structural change where the concentrations of public services (as well as jobs) are situated in peripheral areas of the Helsinki metropolitan area. According to Ratvio (2012) these are also locations where a big part of the population wants to live, and that the most common way to make a journey in those areas is by private car. When looking at the services of Kela offices, this trend does not appear so bad, but when examining other daily services (which have higher utilization rate) long distances and the increasing amount of consumed greenhouse emissions makes it a real problem. So when considering accessibility, it is more and more important that city planning tools can respond to the development of a network city and solve the land use and traffic problems related to that to find the most sustainable ways to commute in this area.

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# Analysing multimodal accessibility and mobility in urban environments: Examining accessibility of 24 hour grocery stores in the capital region using MetropAccess tools

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## 1 Introduction

Spatial accessibility is a topical theme that affects every one of us in our daily life. The “free choices” that we make regarding the use of services may not be as free as we think, but highly dependent on spatial and temporal accessibility of a given service. Progress in accessibility studies and the trend of open data have made it possible to survey the accessibility patterns in more sophisticated ways.

The aim of this study was to examine the spatial accessibility patterns of 24h grocery stores located in the Greater Helsinki region. Together with analysing the accessibility of 24h stores, the other objective of the study was to test and use the accessibility tools (MetropAccess Digiroad and Travel Time Matrix) developed by the University of Helsinki accessibility research group. Tools were used to analyse the accessibility of chosen 24h stores by car and by public transport. Results were visualized in ArcGIS and altogether five accessibility maps were made.

## 2 Background

Locations and the spatial accessibility of grocery stores, as well as other commercial services, has been a widely researched topic in accessibility studies already since the 1990s (Benoit & Clarke, 1997). Various points of view have been applied in studying retail trade such as grocery stores and their accessibility during the past few decades. Some of the more popular views have been the entrepreneur’s point of view, or the business discourse (Hernández & Bennison, 2000), the equity discourse (Apparicio et al., 2007) and various methodologically oriented approaches. One of the most recent contributions to the discussion concerning methodology was made by Maria Salonen in her 2014 doctoral dissertation.

Spatial accessibility analysis is a fundamental part of GIS that can be implemented in either very simple or advanced manner (Dahlgren, 2008). It has been common practice to use Euclidean distances for accessibility analysis in, for example, areas with dense infrastructure networks, where this distance approximation produces satisfactory results (Dahlgren, 2008; Apparicio et al., 2008). However, despite being sufficient in some cases, the Euclidean distance method has obvious limitations in cases where the direct path is a poor approximation of the actually available routes. In recent years, the availability of new types of spatial data and increases in computational resources have enabled the development of more sophisticated methods for measuring spatial accessibility (Salonen, 2014).



Tools used in this study, MetropAccess Digiroad and MetropAccess Travel Time Matrix are developed by the accessibility research group of University of Helsinki. Same tools have been recently used by Perttu Saarsalmi in his 2014 master's thesis that examines the spatio-temporal accessibility of the grocery trade in Helsinki region. Saarsalmi's study is an interesting baseline to our study, since his night time (1:00 am) accessibility maps can be compared to our results.

### **3 Study area, materials and methods**

Study area for this work is the capital region of Finland, including Helsinki, Espoo, Vantaa and Kauniainen. We are concentrating on the central areas, mainly in Helsinki due to 24h stores being non-existent on the periphery of the region.

In total, 11 24h grocery stores were examined, which were collected from large store chain's websites. This approach may result in us missing some locations which do not belong to any of those chains, but we find it unlikely there are many of them. Furthermore, due to the methodological focus and nature of this work, getting 100 percent real life applicable data isn't entirely critical. We also decided not to include any gas stations, since while you can often buy some groceries there; they are inadequate for fulfilling one's daily needs alone. A list of stores used in the analysis is at the end of the report.

MetropAccess research group provided us with tools and materials for most of the work. MetropAccess Digiroad (MetropAccess, 2014) is an enhanced version of the national road database, including impedances caused by traffic added by the research group, as well as ArcGIS tools to better operate this data. Another set of base data originating from the group is the Travel Time Matrix, including travel times from each 250x250m cell in the region to every other, via public transport, car and walking. In our analysis we combined these with SYKE YKR grid with number of inhabitants per each 205x250m cell, in addition to few basic visualization layers. Unfortunately our YKR data did not include more information, thus more advanced demographical examination was not possible. ESRI ArcGIS and Microsoft Excel were the main programs used in the work.

The service area map was generated with the service area tool in Arc. We chose the model without extra impedances due to night-time traffic being usually sparse enough to drive according to speed limits, if not faster. Street parking fit grocery stores best. Maximum 20 minute to and back trip time was deemed reasonable for someone often needing to do night-time shopping, with the addition of 40 minute to and back zone to get a larger picture and to see how parking time affects how much distance a driver can cover.

The second set of maps was produced from the time matrix combining each cell's data which had a 24h store within. From these the minimum value was calculated, to get the time to reach the closest store from each cell in the grid. It must be mentioned that the travel time matrix is a snap shot in time, and not from night time, as would be needed for proper examination of this subject.

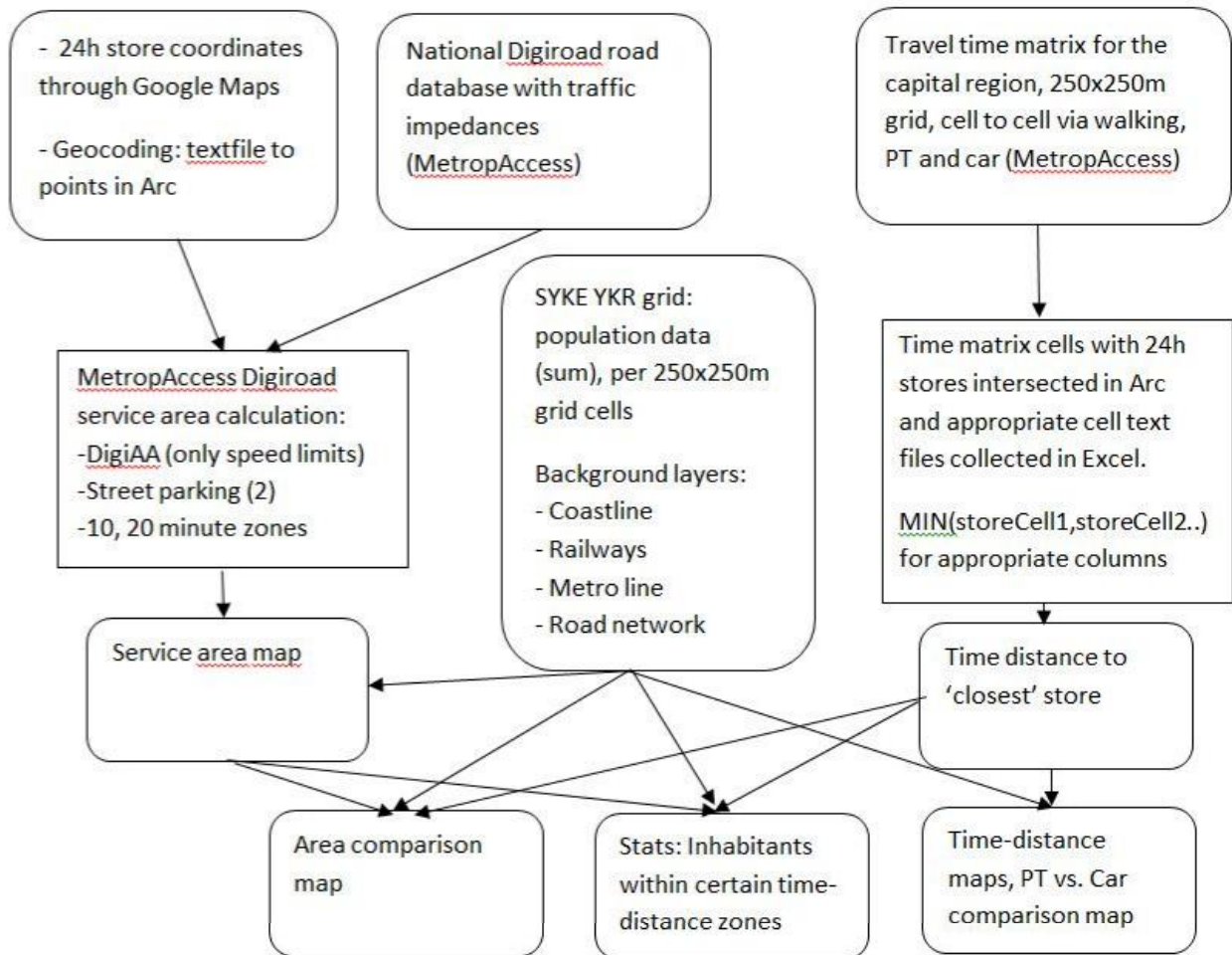
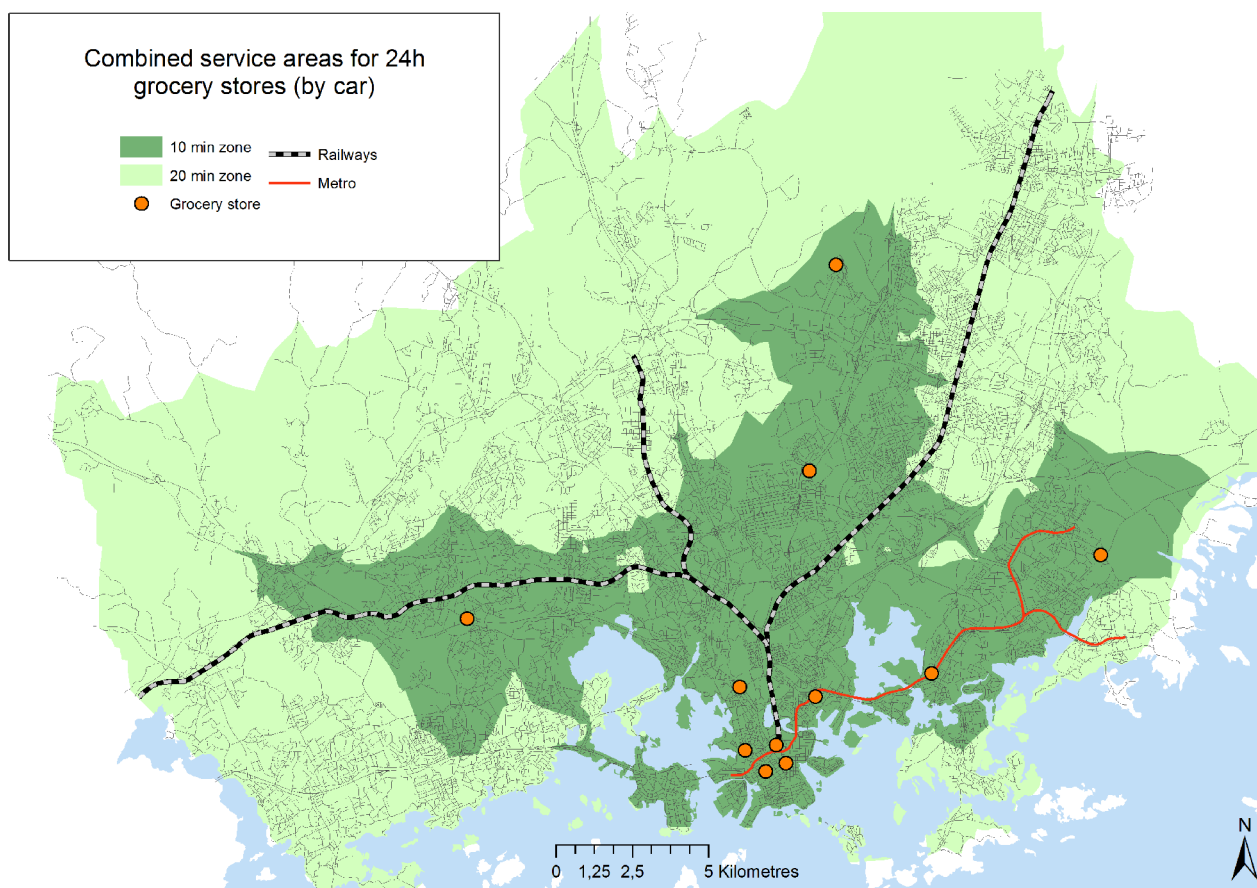


Figure 1. Flowchart describing the work process.

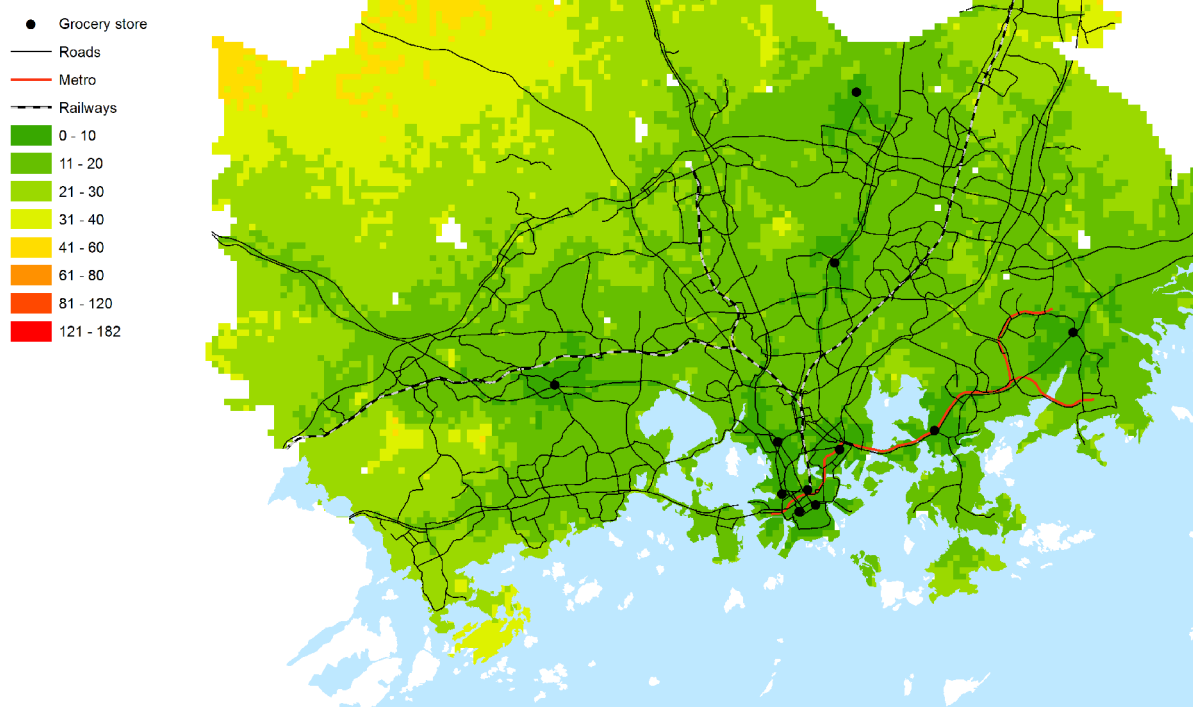
## 4 Results

Without any traffic impedance nearly the entire region can reach one of the stores in 20 minutes, as can be seen in service area map (Figure 2). 1 044 537 inhabitants live within this area, out of 1 052 101 in the entire area, leaving less than ten thousand, or less than one percent beyond. Even in the very reasonable 10 minute zone lives 61.6 percent (648 418) of the population. It should be mentioned that the 20 minute zone extends in parts beyond what was covered by the YKR grid, thus the actual amount of people living within should be somewhat higher.

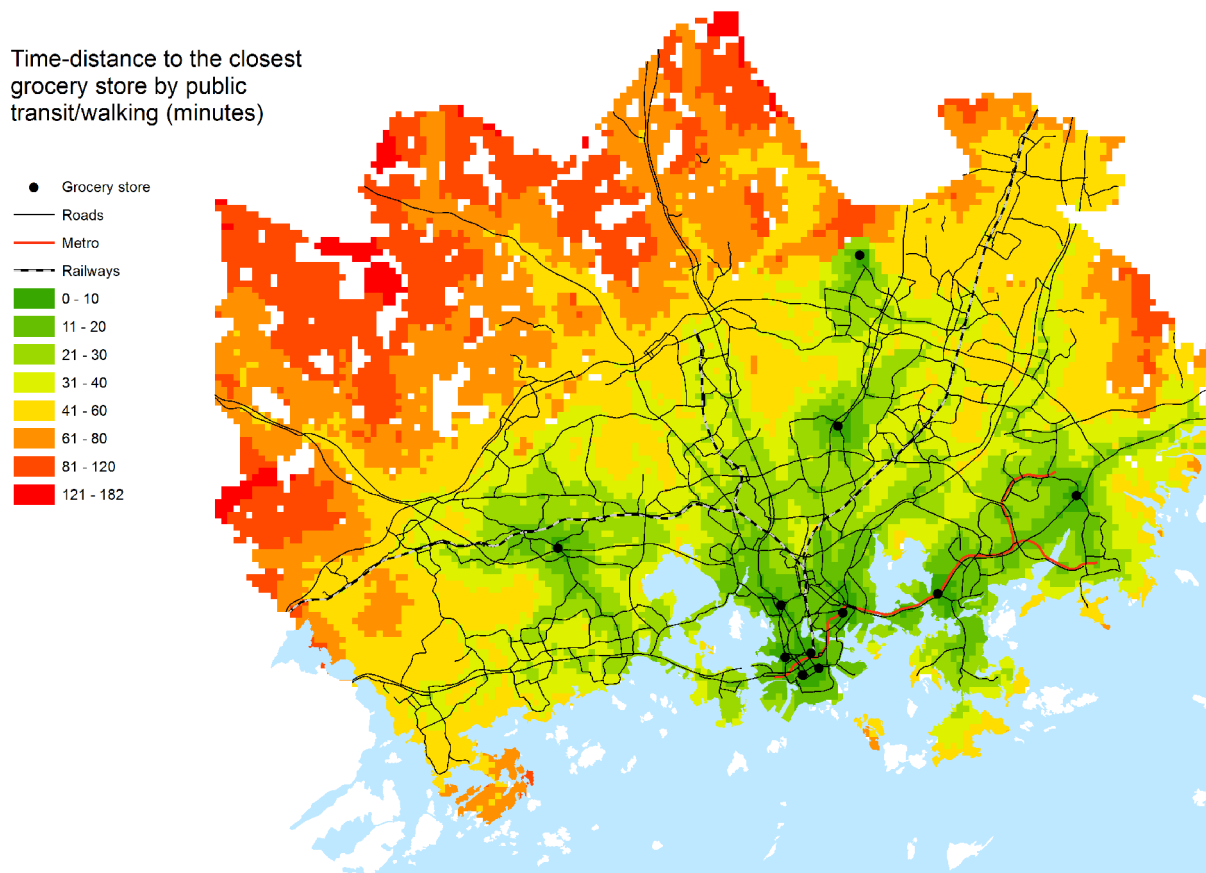


**Figure 2.** Combined service areas for 24h grocery stores by car.

Time-distance to the closest grocery store by car (minutes)



**Figure 3.** Time-distance to the closest grocery store by car (minutes).



**Figure 4.** Time-distance to the closest grocery store by public transit/walking (minutes).

The time matrix which does use impedances, in this case unrealistically, paints a much more moderate picture of areas reachable by car quickly (Figure 3). The granularity of the grid as well as a few extra classes allows us to see the effects of road network more clearly. On the other hand the drawing accuracy of the service area map could have perhaps been tweaked to increase its usefulness further.

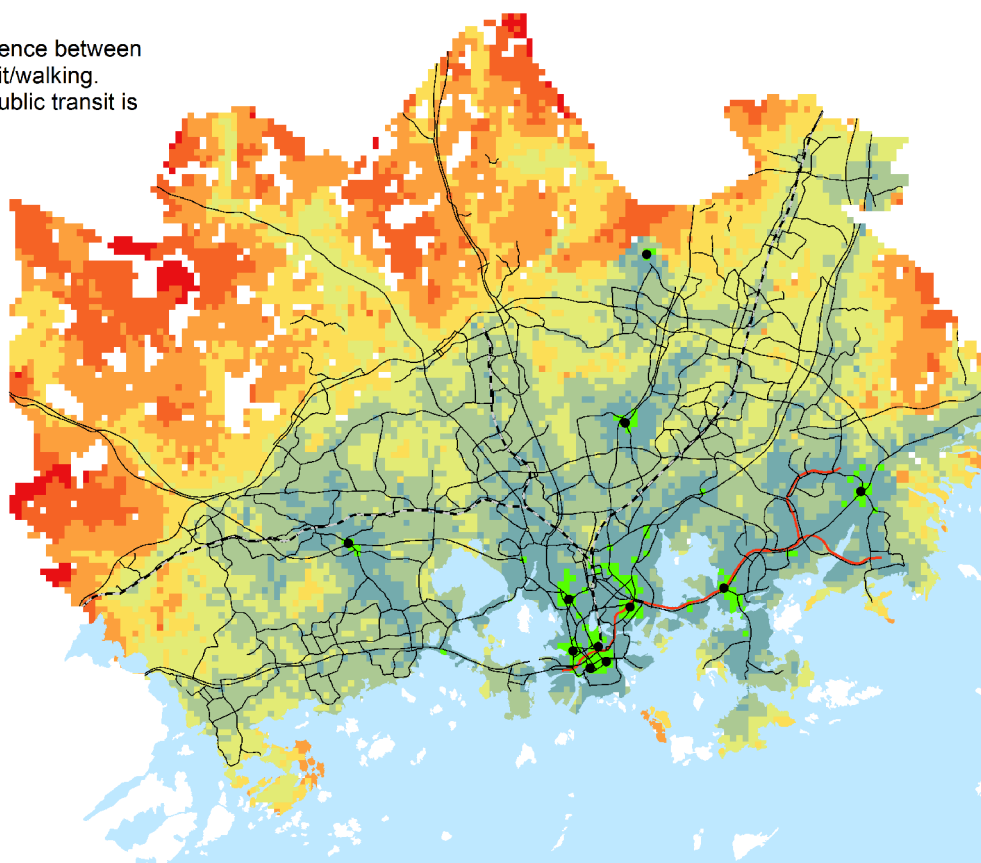
The inclusion of walking makes the public transit map (Figure 4) look more uniform and the effect of most roads is not so pronounced, beside main roads which are used by many different lines. For example, the store in Mellunmäki in the east is comparatively very accessible along the Itäväylä and nearby metro stops.

A comparison between the previous two maps (Figure 5), shows how much slower public transport or walking is compared to driving with a car. There are only small areas, mostly in downtown Helsinki where most of the stores are located, where car is actually slower, and even then the difference is most often trivial. 64 979 people or 6.2 percent live within these areas. The picture shows clearly the effect of public transport only routes, since near metro or railways public transport is much less slower than in the surrounding areas.

Direct comparison (Figure 6) between the 10 minute zone from the service area calculations (raster overlay) and time matrix car times (colours) shows a clear difference between using traffic impedances, as well as the effect of parking times when comparing the time matrix 10 and 20 minute areas.

Time-distance difference between car and public transit/walking. How much slower public transit is (minutes)

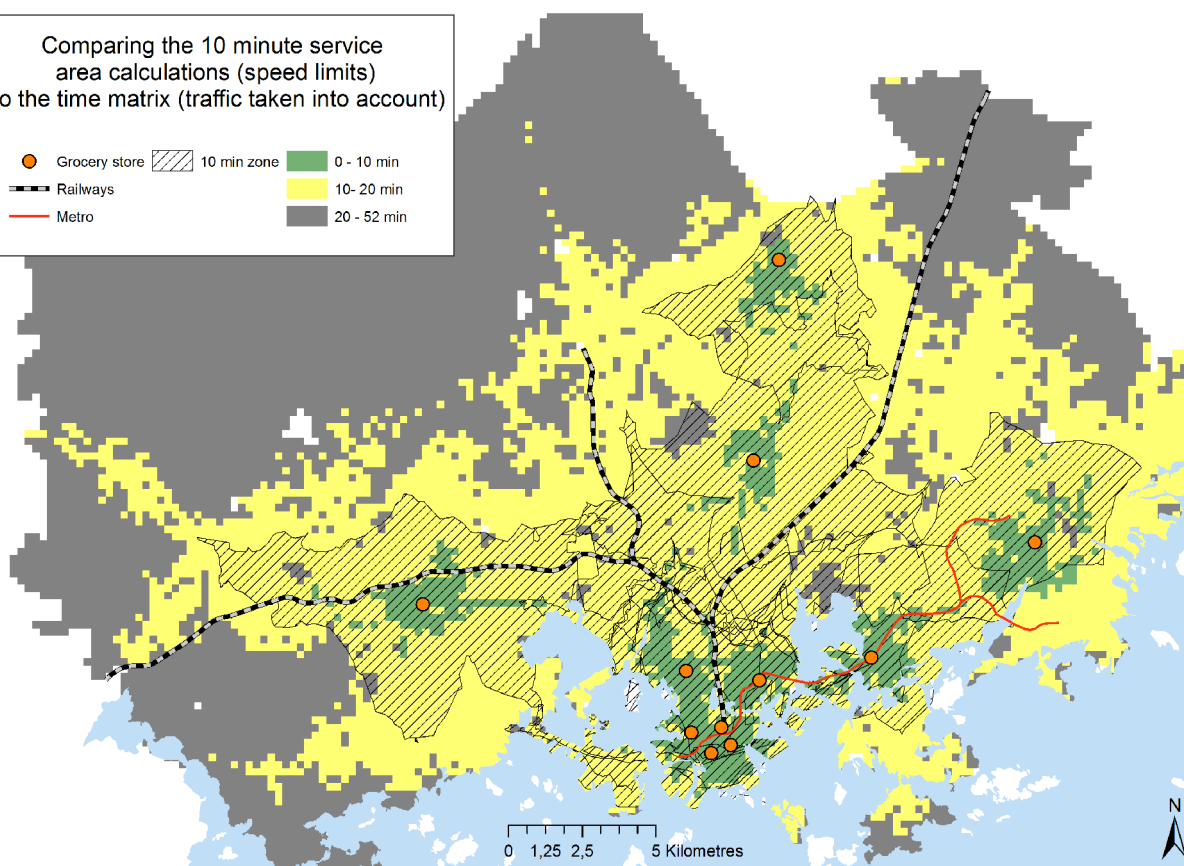
- Grocery store
- Roads
- Metro
- - - Railways
- 0 - 7
- 1 - 10
- 11 - 20
- 21 - 30
- 31 - 40
- 41 - 60
- 61 - 90
- 91 - 144



**Figure 5.** Time-distance difference between car and public transit/walking. How much slower public transit is (minutes).

Comparing the 10 minute service area calculations (speed limits) to the time matrix (traffic taken into account)

- Grocery store
- ▨ 10 min zone
- 0 - 10 min
- 10 - 20 min
- 20 - 52 min
- - - Railways
- Metro



**Figure 6.** Comparison of the 10 minute service area calculation (speed limits only, raster overlay) to the time matrix (traffic taken into account, green, yellow and grey areas).

## 5 Discussion and conclusions

Though interesting as far as testing tools and provided materials goes, for value extracting purposes the methods used fall flat. Since the time matrix is a snapshot, it should come from night-time. As this is not the case all results pertaining to public transport are essentially meaningless. Day-time public transport times tell us nothing about how people can travel to 24h stores at night.

Another cave-eat with public transport times is that ten minutes spent walking is not the same as ten minutes spent walking with a heavy bag. Thus only very short walking times should be taken into account when calculating PT/walking times. What that amount should exactly be is beyond our considerations in this report. This would cause problems with the data, and most likely require a specific matrix with modified PT times. In journey planner, from which this part of the data is originally extracted from, you can specify to use the route with the least amount of walking, but this might cause some peculiar results when used during the night when there are fewer lines operating.

Similarly parking times used in the calculations are based on averages, which might not be very accurate during the night. For example in downtown it could possibly be even harder to find a parking spot from the streets due to most local inhabitants being at home. Most likely though finding a parking space is faster during night, especially if the store in question has a dedicated parking lot, for example like the Alepa in ABC Nihtisilta. Furthermore, things like seasonal variety (snowy winters) could be taken into account, should the tools be updated to accept modifiers to parking times.

On the other hand car based accessibility measures function perfectly, and illustrate how the capital region is very accessible via car, especially if there is not much traffic. Yet, for most purposes, if not for this report, the lack of traffic impedances severely limits the usefulness of Digiroad data. As such the MetropAccess modifications are a welcome addition to alleviate this weakness.

Generally the tools are effective for various analyses and provide much more accurate results when traffic ought to be taken into account. Yet as always, one should be careful when applying standardized methods without first considering whether all the base assumptions all valid for the specific question being analysed. Still, at least in our case, most problems could have been solved by tailoring the base data to suit our specific needs.

## 6 Summary

The spatial accessibility of 11 24h grocery stores in the Greater Helsinki region were examined. The analyses were made by using MetropAccess-Digiroad and MetropAccess-Travel Time Matrix tools, which were provided by the accessibility research group of University of Helsinki. Analyses were carried out with ESRI ArcGIS and results were visualized as five separate maps demonstrating the accessibility in different cases.

As interesting as the tools and the study question were, methods weren't perfectly suitable for the chosen question. Tools only gave the day-time snapshot of the public transport times, and that wasn't useful in the case of studying accessibility at night-time. Car based accessibility measures worked out



better, and the time-distance map to the closest 24h grocery store by car gives a good picture of the real driving times even though it shouldn't be taken as a truth as such. Service area map gives maybe a too optimistic picture of the situation since it is done without taking the traffic impedance into account.

The comparison of time-distances to the stores between car and public transit/walking reveals that the areas where the public transport is faster than car are mainly located in downtown Helsinki. Only 6.2 percent of the total population of the Greater Helsinki area live within these areas and so the car is unbeatable when looking at the accessibility of the grocery stores at night-time.

All in all the tools used were identified to be effective and capable of providing much more accurate results than the basic non-modified Digiroad can provide. When the base data is compatible with the tools and the base assumptions are filled, the methods used can produce very informative data.

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## Appendix

### List of stores used in the report

Address	Name
Elielinaukio 5, 00100 Helsinki	Alepa Eliel
Hämeentie 25, 00500 Helsinki	Alepa Hämeentie
Hiihtomäentie 14 , 00810 Helsinki	Alepa Herttoniemi
Mannerheimintie 102, 00250 Helsinki	Alepa Mannerheimintie
Mechelininkatu 5, 00100 Helsinki	Alepa Mini Mechelininkatu
Lönnrotinkatu 24, 00180 Helsinki	Alepa Lönnrotinkatu
Ohrahuhdantie 8, 00680 Helsinki	Alepa Tuomarinkylä
Nihtisilta 4, 02630 Espoo	Alepa ABC Nihtisilta
Lentäjätie 3 , 01530 Vantaa	Alepa Lentoasema
Etelä-Esplanadi 20, 00130 Helsinki	Siwa Etelä-Esplanadi
Rukatunturintie 2, 00970 Helsinki	Siwa Mellunmäki



# Analysing spatial accessibility patterns in urban environment: Urban Parks in Helsinki

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## 1 Introduction

Infrastructures as an aspect of transformation have brought new life to communities and had great impact on the lifestyle of citizens and urban spatial structure. Mainly segregation, in two forms of spatial and social, is the major consequence of this phenomenon in cities. While in traditional way of living, street networks had a direct correlation with the historical memory of citizens; motorized transportation network, private cars and public transport, altered the historical urban tissue as an uninvited guest. In the meantime, governing policies had an important role in the imbalanced development and provided access inequality for residents, hence defining a new type of poverty: “poverty of connection” (Carmona et al., 2003; Graham, 2001).

Inappropriate access to public spaces as well as the whole city intensifies the spatial and social segregation and restricts elderlies, housewives and children to local scales in time and space. This could accelerate the social and economic marginalization process for these people and their surroundings.

Excessive attentions to the physical aspects of development as well as lack of attention to quality characteristics of neighbourhoods led to the reconsideration of organizing patterns of urban open spaces at the mid and late twentieth century and the spatial organization of open spaces became more important (Marcus, 1998; Oldenburg, 1999; Woolley, 2003). Additionally, the role of urban open spaces in urban regeneration and how they enhance the residents’ life quality became important for political decision makers as well (Council of Europe, 1986).

In addition, quantitative and qualitative characteristics of urban open spaces such as “amount of public green spaces per inhabitant”, “public parks” and “recreation areas” are always considered as part of sustainability indicators that enhance the life quality of inhabitants (Chiesura, 2004). Moreover, in city scale many scholars recognize green spaces and public parks as “a place to relax” (Bishop et al., 2001), places for “isolation from the din of the city” (Gobster, 2001) or places to “escape from the city” (Chiesura, 2004).

The main goal of this research was providing a socio-spatial model for better understanding of the current situation as a part of the urban design process towards sustainable neighbourhoods. In this regard the spatial distribution pattern of parks in neighbourhood and city scales in Helsinki is analysed. Neighbourhood parks serve as recreational and social gathering space for the residents in a close walking distance from their homes. They have important role to create a ‘sense of place’ for neighbourhoods. They are ideal places for active and passive recreation activities for all age groups.

This study will answer the following questions:

- How urban open spaces (parks) are accessible in Helsinki from its city centre?
- Are urban open spaces (parks) distributed homogeneously in Helsinki and to what extent they are close to inhabitants' homes?

### *Helsinki as the case study area*

Helsinki, the capital of Finland, is the main part of the Greater Helsinki, the capital region of Finland. Helsinki is the most densely residential area in Finland with more than 620 thousands inhabitants in 2014.<sup>1</sup> Apart from the natural green areas including forests and preserved areas, there are many parks, green areas and playgrounds in the city of Helsinki.<sup>2</sup> This green environment turns Helsinki to a liveable area for residents as well as an attractive destination for tourists.

## **2 Data and methods**

In order to address the research questions two types of spatial accessibility analyses were performed:

- Analysing spatial accessibility pattern of urban parks from city centre of Helsinki (routing analyses walking/cycling, car and public transport models)
- Analysing spatial accessibility pattern of urban parks from all inhabitants residential areas (routing analyses walking/cycling model)

### *Destinations*

In this research, destinations were selected from the following categories of Helsinki's services map<sup>3</sup>:

#### *Culture and leisure category:*

- *dog areas*
- *green areas*
- *playgrounds*
- *wading pools*

Among these services, playground and green areas in Helsinki were selected (307 destinations totally, 290 playgrounds and 17 green areas) and they have been called parks through the rest of paper. Based on available datasets, their location in the city was the only criterion for their selection and many other factors such as size, spatial quality, number of entrances (access to different streets) and the gravity of attraction in their vicinity (such as malls, museums and cafes) were not considered in this research.

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1 - <http://www.visitfinland.com/helsinki> retrieved 9.11.2014

2 - <http://www.hel.fi/palvelukartta> retrieved 9.11.2014

3 - <http://www.hel.fi/palvelukartta> retrieved 9.11.2014

### *From city centre*

In this part, Helsinki city centre, near railway station was defined as the origin point for daily trips to urban parks in Helsinki and a set of routing analyses was performed for walking/cycling, car and public transport models to all the Helsinki's parks as destinations for tourists.

Public transport assumed as the major transport mode to these destinations while other modes, cars and walking/cycling, can also be used.

### *From inhabitants' area*

For the second part of the research, the focus was on neighbourhood scale and the accessibility patterns of all residents to the closest park in their vicinity were analysed based on the centroids of inhabited grid cells in Greater Helsinki (Statistic Grid database, YKR 2013). Like the previous step urban parks were selected as destinations and similar routing analyses were conducted for walking/cycling modes.

Many residential neighbourhood design guidelines address the service area radius for these parks as well as a range of desired activity that could be occurred there. Among them 400-800 meters radius has been considered as primarily service area for residents to find their recreational needs, passive and active activities, in these parks near their homes.<sup>4</sup> For such a distance, less than 10 minutes, walking and cycling are the only logical options. Therefore, unlike the previous stage, the main focus was on the non-motorized transport, walking/cycling.

### *Workflow of the study*

- Specifying origins (city centre/centroids of inhabited grid cells) and destinations (Helsinki's parks)
- Preparing required input files for MetropAccess tools (Digiroad and Reititin)
- Calculating travel times and network distances between all origins and all destinations
- Defining classes for data analysing, reasonable travel time and distance to reach the destination(s)
- Determining spatial accessibility pattern based on distance, length of journey and reached population
- Comparing travel times and distances between the different models
- Visualizing the results as maps and graphs

## **3 Results**

### *From city centre*

In order to assess spatial accessibility patterns of urban parks near city centre of Helsinki, MetropAccess tools were used and repeated measures were provided. The results obtained from the preliminary analysis of catchment areas around city centre are shown in Figures 1 and 2.

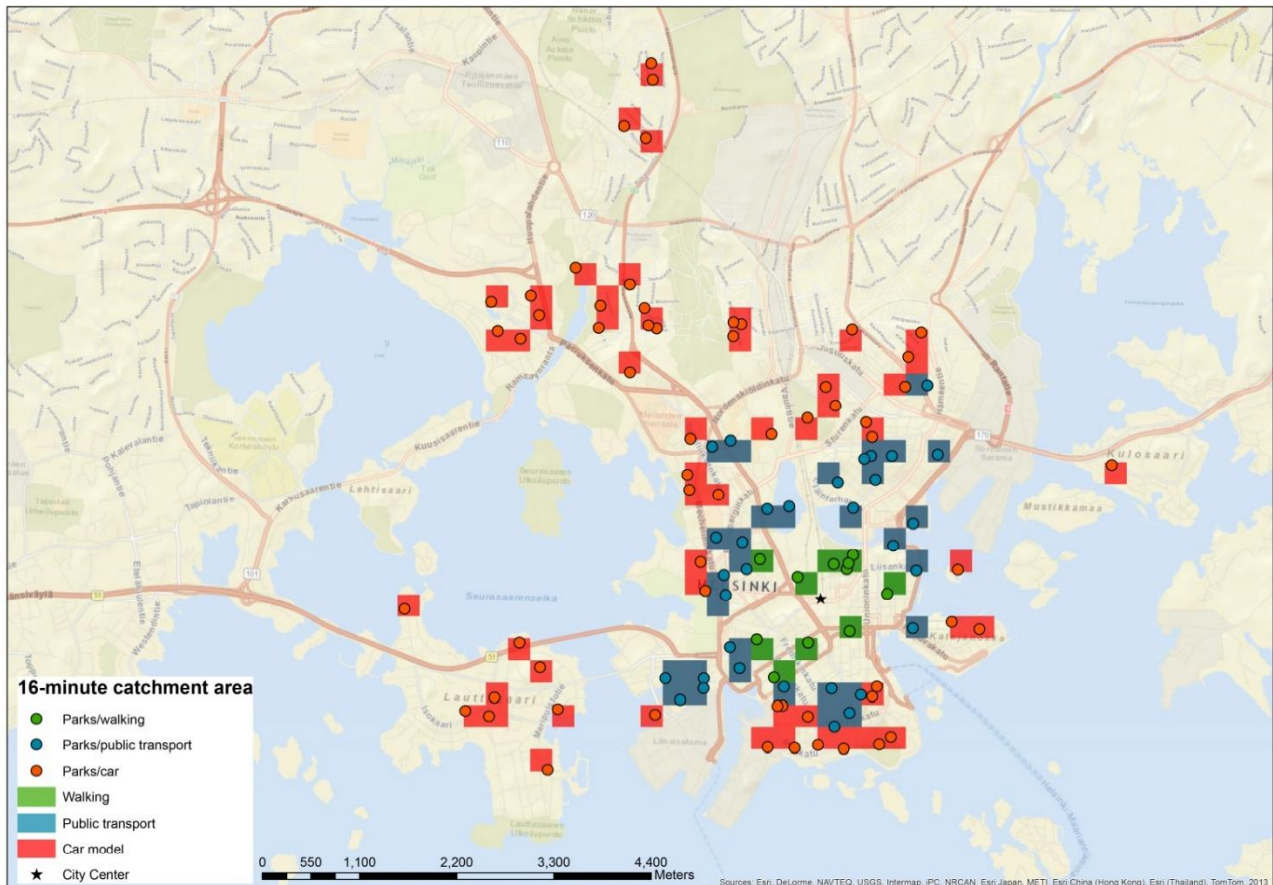
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<sup>4</sup> - [http://www.healthypaces.org.au/site/open\\_space.php](http://www.healthypaces.org.au/site/open_space.php), retrieved 9.11.2014

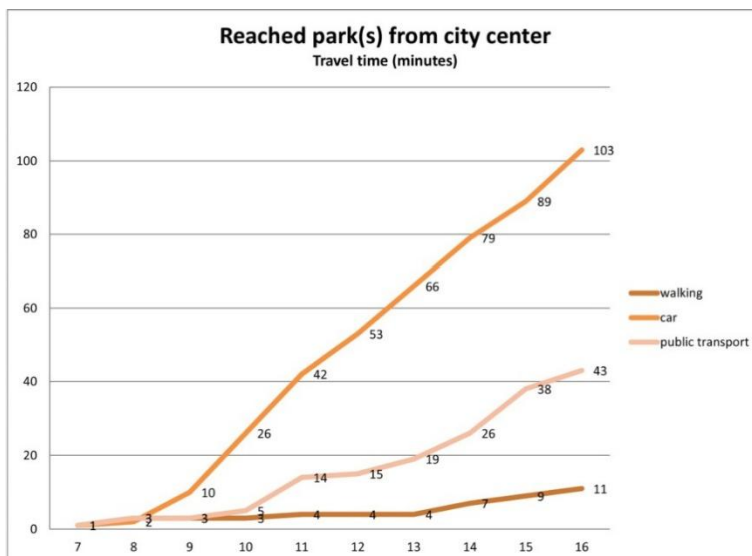


It is apparent from Figure 1 that private car model provide more catchment areas in 16 minutes interval and there is no possibility of competition for walking/cycling or public transport model after 9 minutes.

On the other hand, in the timeframe of less than 9 minutes, accessibility ratio to the parks is approximately equal. In 8-minute travel time 3, 2 and 3 parks are reachable by walking, cars and public transport models respectively.



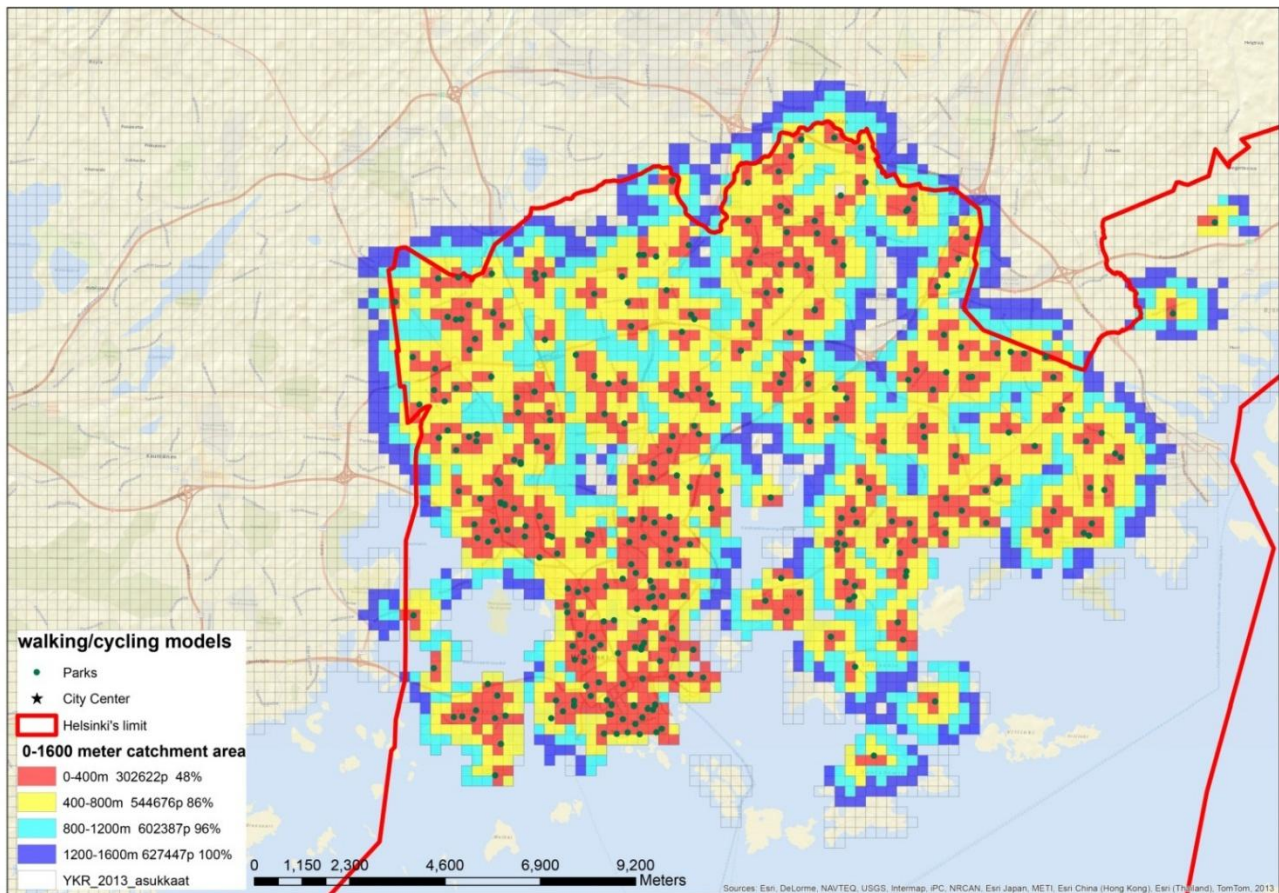
**Figure 1.** Spatial distribution of reached parks around city centre in 16-minute travel by walking, car and public transport models.



**Figure 2.** Number of reached parks around city centre in a 7-16 minute travel time period by walking, car and public transport models.

### *From inhabitants area*

Figure 3 provides an overview of 0-1600 meter catchment areas by walking or cycling around all centroids of inhabited grid cells in Helsinki. As mentioned in the previous section, the optimal service area radius for neighbourhood parks is approximately 10-minute walking distance, 400 to 800 meters. From the data in Figure 3, it is apparent that half of Helsinki's inhabitants have access to at least one park in their residential areas in less than 400 meters walking distance. The most surprising aspect of the data is in accessibility rate of inhabitants, more than 86%, in 400-800 meters walking distance.



**Figure 3.** Catchment areas by walking or cycling around all centroids of inhabited grid cells in Helsinki. Almost all inhabitants have the opportunity to reach at least one park in 800-1200m walking/cycling distance, 96%.

The first set of analyses examined walking distance from centroid of each grid to nearest park. The similar analyses were performed to assess the accessibility to these parks in 1-15 minute walking intervals (70m/s) (Figure 4).

From Figure 5, it can be seen that 14% of residents reach the nearest park in less than 3 minutes, 54% of residents have this chance to spend their free time in a park within 5-6 minutes walking while 15% of inhabitants are somehow living far away from the parks, within more than 10 minutes walking distance.



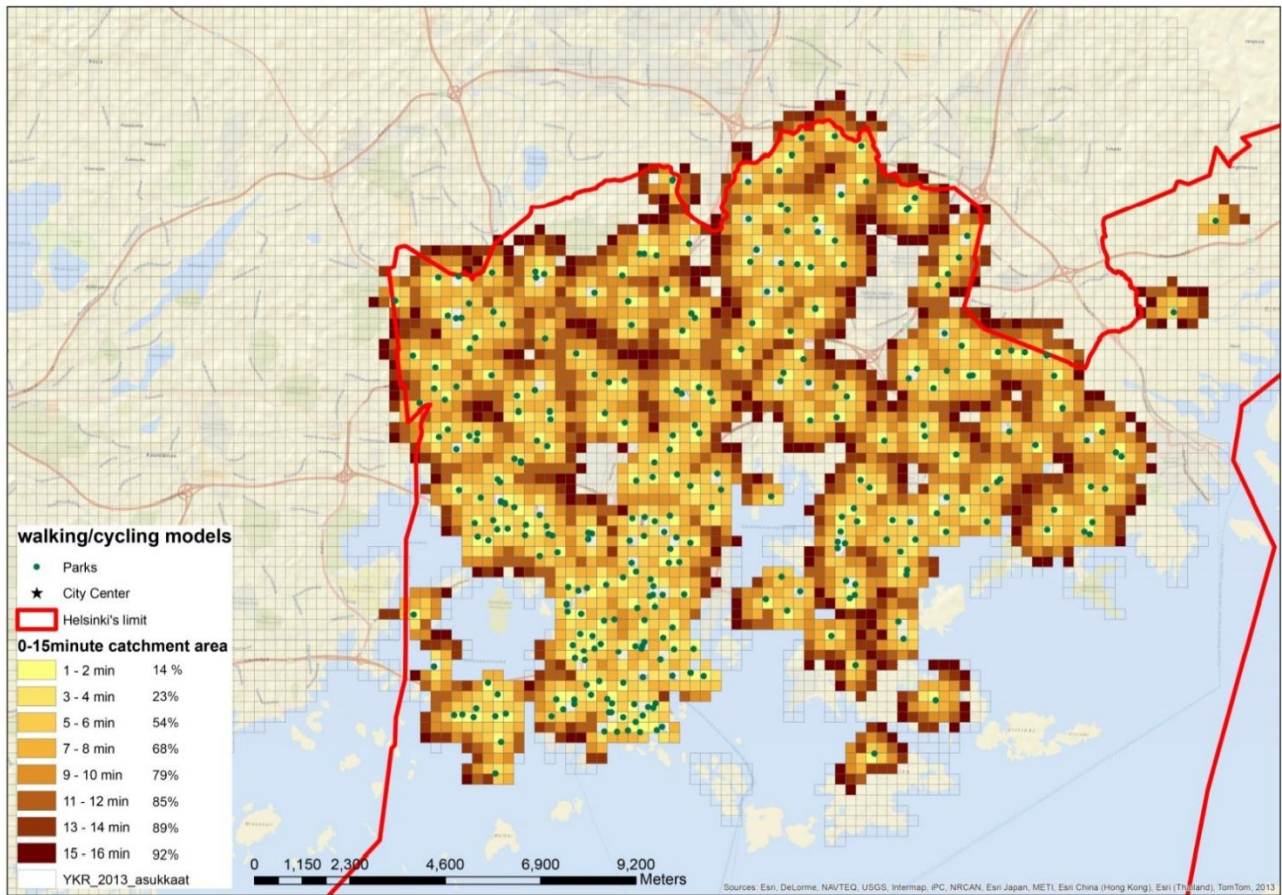


Figure 4. Spatial distribution of travel time ratios for 1-15minute intervals in walking model.

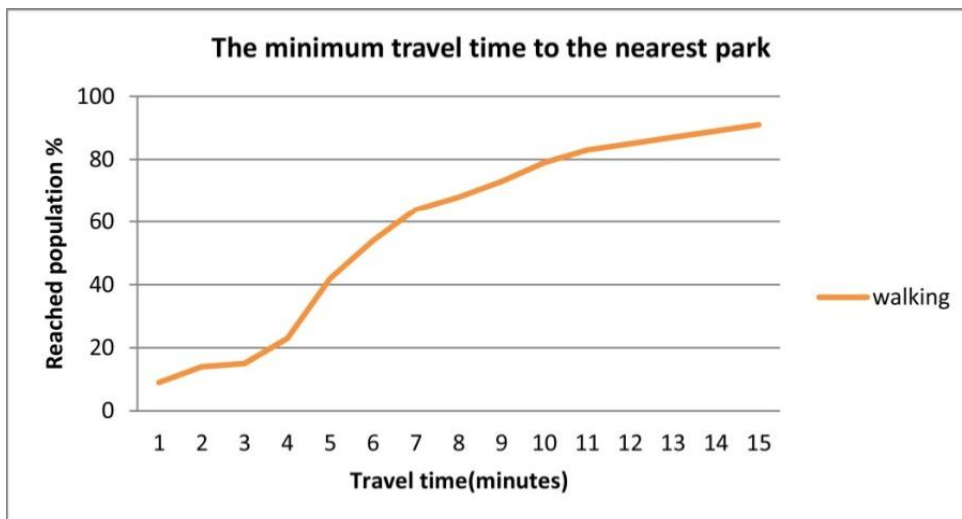


Figure 5. The minimum travel time to the nearest park within 1-15 minute intervals in walking model.

## 4 Discussion and conclusions

### *From city centre*

Like other European cities where traffic regulations for cars are more restrict in city centres, Helsinki's city centre shows similar behaviour. Walking/cycling and public transport models are more efficient up to 8-minute travel time but when travel time increases car model offer a wider range of choices. Just in 10-minute, 25 parks are accessible, five times more than public transport model and 8 times more than walking model.

### *From inhabitants area*

Preliminary results indicate that parks are not distributed homogeneously in different parts of Helsinki while accessibility ratio to closest park is quite high.

Helsinki's inhabitants near city centre have better access to closest park. In other parts of Helsinki at least 15% of residents have no access to parks within more than 10-minute walking radius. By reviewing spatial accessibility pattern of parks, 15-minute catchment area covers 92% of residents. Overall, these results indicate that private cars are the fastest transport model in Helsinki while it has its own difficulties (parking place) and costs. In other hand, those who use public transport somehow suffer from poverty of connection.

On the other hand, this set of approaches provides a spatial distribution pattern of urban parks that would be beneficial in urban development process and helps the decision makers to identify where to construct new parks in upcoming urban development projects.

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# **Abstract: An environmental justice perspective to the multimodal accessibility of aquatic environments in Helsinki Metropolitan Area**

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## **Abstract**

*(An extended version of the course report was submitted to a journal - thus only the abstract is available here.)*

As the spatial distribution of services, such as sport and recreation facilities or parks and other green or blue spaces, and the differences in access to such can have potential health and social welfare implications, ensuring equal accessibility is highly important and should be of interest to urban planners, policy makers and health officials. Yet, the service area analyses are often based on arbitrary travel-distance thresholds for a single mode of transport. In this research Public Participation GIS (PPGIS) method was used to empirically investigate the distances and durations that respondents travel with different modes of transport to access the popular water recreation environments in Helsinki Metropolitan Area. The service area analyses are based on these individually based and objectively measured threshold values that take into account not only the spatio-temporal elements of transport networks and land-use component, but also recognize the requirements and preferences of individuals and their capacity to access and participate. The study notes that PPGIS methods provide novel, spatially bounded person-based research possibilities for accessibility studies. The results indicate that the overall accessibility of popular water recreation environments within the HMA is rather equal. The residents in HMA travel fairly long distances and time to access water environments, by foot in general 1.7 km and 24 minutes. The results demonstrate the potential of PPGIS for the research on accessibility and the service area delineate.